The Court of Last Resort: A Reassessment of Agency Costs in the UK Takeover Market

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Abstract

This thesis examines the role of agency costs in the context of takeover markets, which leads to a better understanding of the functioning of the market for corporate control and takeover likelihood. There has been considerable previous research on the main topics considered here but using new methodologies and techniques, a number of contributions to the literature are identified. The thesis contributes to the literature by (1) reassessing bidding firm abnormal returns, (2) using takeover likelihood to identify a detailed view of the market for corporate control with regards to disciplinary targets on the basis of agency costs and agency costs of free cash flow.

In a sample of successful takeover announcements from UK bidders between 1995 and 2014, half of modelled events display ARCH effects. We apply the appropriate GARCH models to correct market model parameters estimated during the market model estimation period. We find that the standard market model overstates betas when ARCH effects exist, in turn leading to an overstatement of negative Cumulative Average Abnormal Return. Significant differences between the market model and GARCH adjusted model are identified. Our results show agency costs to bidding firms, consistent with previous studies. But returns must be somewhat upwards corrected. These differences do not translate to significantly different coefficients in CAR prediction models. Conclusions of such prediction models are thus unaffected by GARCH adjustment.

The second empirical chapter tests whether agency costs predict takeover likelihood and if the takeover mechanism disciplines inefficient management. The approach is to identify candidates for disciplinary takeover on the basis of excess return

and Tobin's Q from a sample of companies with primary listing in London between 1986 and 2016. When using the lowest decile for excess return to identify disciplinary targets, takeover risk increased but little evidence was found to indicate that fundamental agency cost indicators were related to takeover risk. The market was more selective regarding companies in the lowest decile of Tobin's Q. These companies appear undervalued and, therefore, improved managerial efficiency is likely to enhance company value.

In the third chapter, the disciplinary candidate identifier is adjusted to detect agency costs of free cash flow. A set of company-year observations with high free cash flows but where growth opportunities for investment of that cash were lacking, was generated. Specifically, we required both Tobin's Q to exceed, and free cash flow on assets to fall below, industry-year cut-offs at the quartile and the median. However, we only find limited evidence for such companies being disciplined in takeover markets. We did not observe strong evidence for companies' ability to adjust takeover likelihood by distributing cash to investors. These findings imply that agency costs of free cash flow are regulated through means other than the market for corporate control.

The findings presented in this thesis provide a set of implications for researchers, practitioners, as well as regulators and policymakers. For researchers, the evidence in this thesis suggests that ARCH effects should not be ignored when performing event study methodology. When researching the market for corporate control, the cut-off point for excess return and Tobin's Q must be set relatively low for the classification of the disciplinary set - in our study at around 10% to 20% of the sample. Regarding agency costs of free cash flow, it is not sufficient to use low Tobin's Q alone and overlook free cash flows. For practitioners, the results on bidding firm abnormal returns demonstrate that previous findings of long-term underperformance must be somewhat upwardly corrected, even though our findings confirm previous studies which show that UK acquisitions do not create value for acquirer shareholders. Through the study of takeover likelihood, a well-functioning market for corporate

control is observed in the UK. What is important is the display which companies are likely to be disciplinary candidates. The evidence suggests that agency costs of free cash flow are not a significant determinant of takeover likelihood in the UK market for corporate control. For regulators, the main implication is that an open merger policy is desirable if a functional market for corporate control is expected to protect shareholders from agency costs.

Dedicated to

my grandmother, Jutta Brenne,

for insisting.

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Abbreviations

AAR Average Abnormal Return.

ACFCF Agency Costs of Free Cash Flow.

AFT Accelerated Failure Time.

AR Abnormal Return.

ARCH Autoregressive Conditional Heteroscedasticity.

ARMA Autoregressive Moving Average.

CAAR Cumulative Average Abnormal Return.

CAPEX Capital Expenditure.

CAR Cumulative Abnormal Return.

CEO Chief Executive Officer.

Cox PH Cox Proportional Hazards.

EBIT Earnings before Interest and Taxes.

eGARCH Exponential GARCH.

GAM GARCH-Adjusted Model.

GARCH Generalised ARCH.

GBP Pound Sterling.

GBp Great British pence.

GDP Gross Domestic Product.

HAC Heteroscedasticity and Autocorrelation Consistent.

HMRC Her Majesty's Revenue and Customs.

IM Index Model.

M&A Mergers and Acquisitions.

MM Market Model.

NPV Net Present Value.

OLS Ordinary Least Squares.

PPE Property, Plant and Equipment.

RBS Royal Bank of Scotland plc.

ROA Return on Assets.

tGARCH Threshold GARCH.

TQ Tobin's Q.

USD United States Dollars.

VAR Value at Risk.

Chapter 1

Introduction

In a letter to the board of directors of ABN Amro N.V., dated February 2007, activist investor The Children's Investment Fund Management LLP demanded the search for an acquirer or the breakup of the company with the main justification that the market value did not reflect the value of underlying assets (Degorce 2007). In the following acquisition contest, a Royal Bank of Scotland plc (RBS) led consortium won the auction for ABN Amro at a price of €72bn. The acquisition would prove fatal shortly after, as RBS had to first approach equity investors and subsequently the UK government for funding a write-down of almost £6bn in non-performing loans and to finance the ABN Amro acquisition at costs of approximately £20bn. The UK government purchased new RBS shares at a total value of £25bn, leading to a stake of 68% in the equity of RBS. Throughout the takeover RBS plc's share price fell from 600 Great British pence (GBp) in April 2007 to 15 GBp in January 2009; a return of -97.50% (Telegraph 2010). The UK government still holds 62% of shares today (RBS plc 2018). The case is illustrative for the takeover likelihood associated with low market value of assets and the disciplinary effect on management of companies with low market values in the takeover market, which are central to this thesis.

1.1 Motivation

This thesis aims to provide a better understanding of the functioning of the market for corporate control. We adopt a strong agency cost perspective throughout as we view the two concepts, agency costs and the market for corporate control, as tightly connected. In our approach, the market for corporate control is examined by investigating bidding firm abnormal returns and takeover likelihood, whereas the most common method is to examine abnormal returns in target companies (Jensen & Ruback 1983). We consider this latter approach as insufficient since the premium paid and a general increase in return, due to greater demand in a stock throughout the bidding process, not only reflect positive target abnormal returns but also agency costs to bidder shareholders. Additionally, non-targets are ignored entirely in most such studies i.e. targets are not compared to non-targets.

Bidder abnormal returns are the market's evaluation of merger performance for the acquirer. A negative evaluation is an indication of shareholder money that is not expended in the best interest of shareholders, in other words, agency costs. The approach adopted in this study enhances the benchmarking process when calculating abnormal returns in order to provide a better understanding of the magnitude of value destruction in takeover bids (Dodd 1980, Franks & Harris 1989, Morck, Shleifer & Vishny 1990, Schwert 1996, Agrawal & Jaffe 2000, Walker 2000, Andrade, Mitchell & Stafford 2001, Capron & Pistre 2002, Martynova & Renneboog 2008).

Studying takeover likelihood results in a comparison of targets and non-targets and bidder abnormal returns provides a clearer indication of agency costs. Previous studies of takeover likelihood have only superficially investigated agency costs and the market for corporate control (Dickerson, Gibson & Tsakalotos 2002). We notably extend the dissection of the candidate pool for disciplinary takeovers.

1.2 Objectives and Contributions

The purpose of this thesis is to contribute to the current understanding of the nature of agency costs in the context of Mergers and Acquisitions (M&A). We approach this issue from two perspectives, (1) bidder abnormal returns and (2) takeover likelihood. In the framework adopted in this study, negative bidding firm abnormal returns are a reflection of agency costs and we improve our understanding of this reflection through a refinement of the underlying methodology (Chapter 2). The market for corporate control hypothesis dictates that firms with high agency costs are prone to takeover, which should be translated into an increase in takeover likelihood. In this thesis, we use a wide range of agency cost indicators as predictors of takeover likelihood in combination with a reclassification of disciplinary candidates to reassess the functioning of the market for corporate control (Chapter 3). We also apply a narrower set of indicators in a study examining the effects of agency costs of free cash flow on takeover likelihood (Chapter 4).

Chapter 2 provides a methodological refinement to re-evaluate the classic finding of bidding firm underperformance in financial markets following takeover (Martynova & Renneboog 2008). The basis for this finding is usually derived from event study methodology using Ordinary Least Squares (OLS) modelling. This approach has been demonstrated to be problematic in modelling financial returns (Brockett, Chen & Garven 1999, Engle 2001) when potential Autoregressive Conditional Heteroscedasticity (ARCH) effects lead to efficiency problems that must be modelled (Brooks 2014), which then often lead to mean equation coefficients different from an OLS estimate (Armitage & Brzeszczynski 2011). In an event study, this difference affects the expected return estimation, which translates to a different abnormal return. To address this issue, we conducted an event study incorporating a detection of ARCH effects which are subsequently corrected using a series of Generalised ARCH (GARCH) models. While this approach has been applied in other fields (option expiration effect: De Jong, Kemna & Kloek 1992, divestitures: Corhay & Rad 1996, insurance regulation: Brockett, Chen & Garven 1999), it is a novelty in M&A

research.

In Chapter 2, we seek to answer the following questions: (1) Are there ARCH effects when conducting M&A event studies in the UK? (2) Can models from the GARCH family help ameliorate the estimation problems of OLS when ARCH effects are present? (3) Are the resulting abnormal returns different from standard event studies when using ARCH models? and (4) Do these differences translate to variations in Cumulative Abnormal Return (CAR) cross-sectional models? We identify ARCH effects in around half of modelled events. The application of GARCH type models (GARCH, Exponential GARCH (eGARCH), Threshold GARCH (tGARCH)) led to a significant removal of ARCH effects in the affected events. OLS betas tended to be greater than their GARCH adjusted counterparts, which consecutively lead to an overstatement of abnormal return negativity. When viewing this negativity as a reflection of agency costs, GARCH adjustment did not lead to a reversal of the traditional finding of value-destroying M&A. That traditional finding must, however, be corrected upwards after GARCH adjustment. While there are positive abnormal returns for bidders in short periods surrounding announcement, longer term abnormal returns are negative.

Chapter 3 provides an examination of whether agency costs predict takeovers and if the takeover mechanism disciplines inefficient management. We approach the problem with two research questions: (1) How effective is the market for corporate control in an economy with an open merger policy? and (2) What agency cost indicators are associated with market discipline? Answering these questions helps to establish the link between takeover likelihood with the market for corporate control and agency costs. The chapter contributes to the literature on takeover likelihood, the disciplining effect of stock listing and agency costs. The link between takeover likelihood and the market for corporate control has previously been made (Dickerson et al. 2002), but we adopt a general agency theory approach. The key differentiation lies in the classification of candidates for disciplinary takeovers. While Dickerson et al. (2002) is limited to classifying disciplinary candidates with a focus on agency costs of free cash flow (Jensen 1986), our approach is to set excess return and Tobin's Q (TQ) in relation to an array of agency cost indicators, which is more consistent with the mechanism hypothesised by Manne (1965). TQ is the ratio of the market value of company assets to the replacement costs of that company's assets. In our sample, we approximate the replacement costs of assets by the book value of assets as in previous literature (for example Danbolt, Siganos & Tunyi 2016, Dargenidou, Gregory & Hua 2016. Our findings help explain the workings of one of the central mechanisms for rectifying systemic and company specific agency costs. Firms that experience a significant fall in share price demonstrate a significantly higher takeover likelihood, but we find no association with agency costs for these takeovers. Stock price falls alone do not indicate a disciplinary effect as stock price effects may indicate a correction to the market value rather than agency costs. When we extended the analysis to takeovers with low TQ (our definition for disciplinary candidates), results reveal that agency cost indicators are associated with takeover likelihood. Given the UK context of our study, in which anti-takeover provisions are disallowed, and compared to the findings of US studies, our results imply support for the effectiveness of an open merger policy if regulators desire a functioning market for corporate control. Our results also demonstrate that the definition applied in Dickerson et al. (2002) is not effective in identifying disciplinary takeovers and confirm the relationship between disciplinary takeovers and agency cost indicators.

A particular subcategory of agency costs is Jensen's agency costs of free cash flow (1986). Chapter 4 combines that theory with the approach to testing the market for corporate control through the study of takeover likelihood and, in doing so, answers the research questions (1) Can we identify companies with free cash flow agency problems? and (2) If yes, are such companies disciplined in takeover markets? The expectation is to observe an increased threat of takeover for firms with elevated agency costs of free cash flow. Our study builds on Dickerson et al. (2002) to further refine the methodology applied to identify companies with free cash flow agency problems. Dickerson et al.'s (2002) method can identify general agency problems but not free cash flow agency problems. In this chapter, a set of disciplinary candidates was identified by requiring both low TQ and high free cash flows for the classification of a case that matches Jensen's (1986) definition. The findings do not indicate a disciplining effect from threat of takeover towards these candidates. Evidence for disciplinary candidates' abilities to adjust takeover likelihood by relinquishing cash to investors is weak. Agency costs of free cash flow seem to be handled through corporate governance mechanisms other than the market for corporate control.

1.3 Background

Agency costs are a crucial concept in fields such as corporate governance, M&A, management theory and business law. Quantifying those costs, however, is difficult. The term agency costs was first introduced by Jensen & Meckling (1976) as a combination of principal agent theory (Mitnick 1973, Ross 1973) with the separation of ownership and control visible in the modern stock-listed corporation with highly dispersed ownership (Berle & Means 1932). Jensen & Meckling (1976) described agency costs as all costs that accrue to shareholders (the principal) due to inefficient behaviour by corporate management (the agent). A subcategory of this cost are the agency costs of free cash flow, where company management holds cash or invests below the firm's required rate of return instead of distributing to shareholders, thereby increasing management's sphere of control at the cost of shareholders (Jensen 1986).

Separation of ownership implies that (1) decision makers do not substantially participate in wealth effects of those decisions and (2) dispersed ownership leads to free rider problems (the payoff of intervention by a single atomic owner is too small to return a positive Net Present Value (NPV) for that owner) (Fama & Jensen 1983). With free rider problems, shareholders are incentivised towards buy and sell decisions over monitoring efforts (Jensen & Ruback 1983). Management of company assets determines market valuation and if that valuation could be increased with more efficient management, the company should become a takeover target with the purpose of improving management and increasing stock price to its true value

(Manne 1965). Manne coined this takeover mechanism 'the market for corporate control' and in light of this theory, depressed stock prices result from inefficient management, which we classify as agency costs. From this perspective, agency costs can be viewed as a driver of shareholder's sell decisions and in turn, the driver of the market for corporate control.

When using event study methodology, observed return of an asset surrounding the event of interest (in our case, takeover announcement) is compared to a benchmark return that indicates the asset's hypothetical behaviour had the event not occurred. The difference between observed return and benchmark return is abnormal return. The magnitude of those abnormal returns and their statistical difference from zero is typically the factor of interest. Event study methodology is presently the primary method for studying the impact of different events on asset returns (Binder 1998). The concept of abnormal returns during events or as new information arrives is closely associated with the efficient market hypothesis, the idea that market prices efficiently reflect all publicly available information (see Fama 1965, Malkiel & Fama 1970, Fama 1971), in the sense that abnormal returns reflect the NPV of new information, such as major investment decisions, from the investors perspective (Fama, Fisher, Jensen & Roll 1969). As a result, negative bidding firm abnormal returns imply a negative NPV for the decision, in our case the takeover decision, which in turn implies agency costs. A similar logical chain does not apply in the case of target firms.

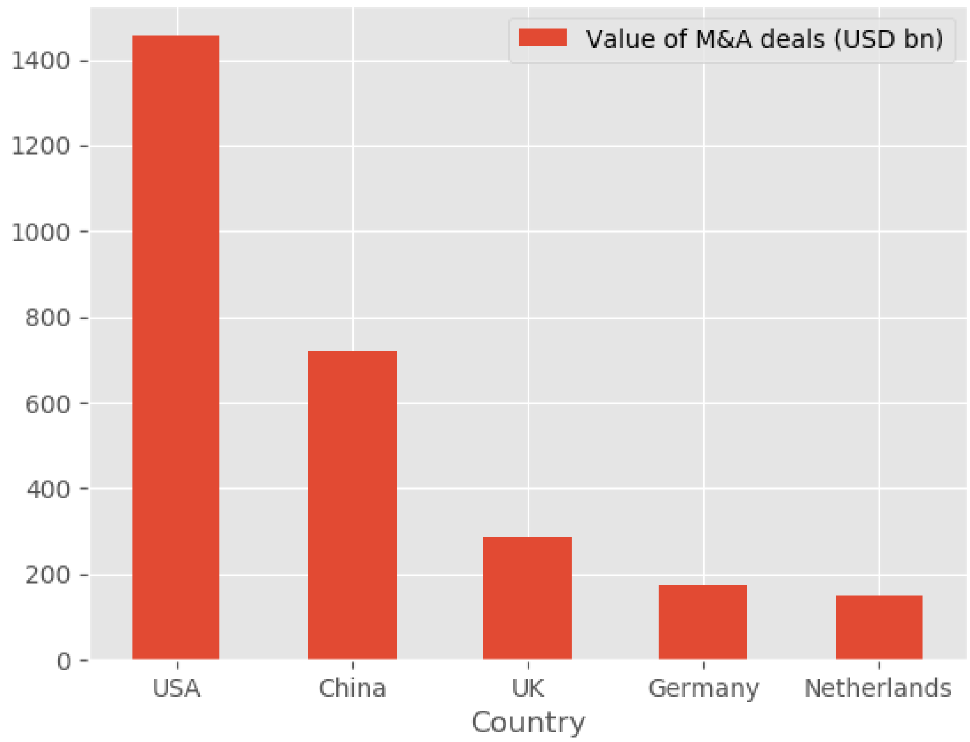
Takeover likelihood predicts which companies become takeover targets before public announcement by comparing lagged public data of targets and non-targets. Takeover likelihood studies initially investigated whether this prediction is possible with a satisfactory degree of reliability (Palepu 1986). More recent studies have rather focussed on the distinguishing attributes between targets and non-targets (Dickerson et al. 2002, Loderer & Waelchli 2015). In our framework, the driver of takeover likelihood in the market for corporate control is agency cost by extension of the separation of ownership and control and the pricing mechanism in equity markets (Dickerson et al. 2002).

While takeover likelihood might be high for well-run targets with strategic benefits or similar cases outside the market for corporate control, the panel nature of prediction models from the survival family enables identification and examination of a set of disciplinary candidates without the omittance of other and non-targets outside this set. A contender to takeover likelihood could be bankruptcy likelihood modelling (Altman 1968, Shumway 2001). While we expect both measures to initially increase simultaneously, when fundamentals deteriorate beyond the point where recovery is possible or environmental factors lead to loss of competitive advantage, bankruptcy likelihood increases, while takeover likelihood should decrease. In contrast, we prefer takeover likelihood for this study of agency costs as it clearly identifies a disciplinary set, likelihood of takeover can be expected to increase when fundamentals or company potential are positive, but management is inefficient regarding the use of company assets.

Sample periods are differing between (a) Chapter 2 and (b) chapters 3 and -4. The main reason for this divergence is a stark difference in methodologies between (a) and (b), requiring the collection of an entirely new data set for the latter. In the takeover likelihood based chapters 5 years of data are required for a firm to be included in the sample so that the 1986 to 1990 are merely for independent variable observation. As such, in effect, both samples cover similar periods in that they start in 1990s and go up unto the last full available year at time of data collection.

1.4 Agency Costs, the UK Market for Mergers & Acquisitions and its Regulation

Takeover markets are an excellent testing ground for studying agency costs. Traditionally, takeover markets have been a key corporate governance mechanism in reducing agency costs (Larcker & Tayan 2015). As previously stated, we hypo-



Deal value acquired by target country and in billion USD for 2017. Adapted from Statista (2018)

Figure 1.1: Value of M&A deals 2017

thesise that this disciplining effect of stock listing will be reflected in (increased) takeover likelihood for a set of disciplinary candidates. The traditional view is that agency costs are also reflected in positive abnormal returns for target firm shareholders (Jensen & Ruback 1983), although targets' shareholders might gain for reasons other than agency costs and is difficult to compare to non-targets, (see Section 1.1). A further clear indication of agency costs in takeover markets is bidder abnormal returns when negative, in a demonstration of the price-finding mechanism that drives the market for corporate control.

The UK's premier stock market, the London Stock Exchange, is considered one of the most developed in the world and was ranked first on the Global Financial Centres Index (Yeandle 2018) in 2018. The UK takeover market is the largest in Europe and the third largest in the world (see Figure 1.1). For its regulatory properties, we prefer this market over its two larger alternatives, the United States (US) and China.

UK takeover regulation is structured with the agency problem in mind and as such orients itself towards shareholder protection. The root of this are cases of anti-takeover provisions used at the expense of target firm shareholders in the 1950s (Okanigbuan 2013). A most influential case was the attempt by private investor Harold Samuel to take over Savoy Hotel Ltd with the intention to convert hotel real estate into office space. The management of Savoy Hotel Ltd reacted with a sell and lease-back agreement containing the obligation by the buyer to maintain the property as hotel space, thereby effectively applying a poison pill to deter the takeover attempt and sparking the anger of shareholders in the process. Whilst the Board of Trade investigated the case, its subsequent report was non-binding (Armour & Skeel Jr 2006, Okanigbuan 2013).

The main bodies of text governing takeovers in the UK today are The City Code on Takeovers and Mergers, published since 1968, in combination with the EU Takeover Directive 2004 (Okanigbuan 2013). The City Code on Takeovers and Mergers has the purpose to regulate takeovers in the UK with the intention to protect shareholders (Burges Salmon LLP 2019). The objective of the EU Takeover Directive is the regulation of M&A within the European Union (Okanigbuan 2013).[1] Both texts are mainly concerned with the interaction of management and shareholders of target firms in situations of bids. A common theme is to reduce powers of management and allow shareholders to decide on bids (Okanigbuan 2013, Burges Salmon LLP 2019). Shareholder primacy is expressed in the non-frustration rule meaning that management cannot accept or reject a bid without approval from shareholders, relegating management to the role of an advisor. Further influence on management behaviour surrounding takeover bids stems from the Companies Act 2006, which again emphasises shareholders' primacy (Okanigbuan 2013) and LSE listing rules which are highly influential on issues of corporate governance (Sudarsanam 2003).

Stronger legal protection for shareholders in takeover situations increases takeover

[1] At the time of writing, it is unclear in what form the EU Takeover Directive will apply or will be replaced with after the UK leaves the European Union. Though large parts of the EU Takeover Directive have been imported into both the Companies Act 2006 and The City Code on Takeovers and Mergers (Okanigbuan 2013), so that even an unregulated exit should not have an immediate (material) impact on UK takeover law.

market efficiency without hurting bidders and the UK has been consistently ranked in first place regarding takeover law strictness during the period from 1986 to 2010 (Wang & Lahr 2017). Anti-takeover provisions, similar to what is common in the US, should be prohibited to improve the function of the market for corporate control (Humphery-Jenner & Powell 2011). In fact, anti-takeover measures are almost non-existent in the UK. Dual share classes are not permitted by the London Stock Exchange, poison pills and staggered boards are rare, employee stock option programs as poison pills are forbidden entirely and golden parachutes and share buyback programs are possible only with shareholder approval, so that the most viable defence against takeover for UK firms is the creation of shareholder value (Sudarsanam 2003).[2] Additionally, free float (the shares outstanding in a company that are publicly tradable) is usually high in the UK, which correlates with cross holdings between UK companies being negligibly low (La Porta, Lopez-de Silanes, Shleifer & Vishny 1998, La Porta, Lopez-de Silanes & Shleifer 1999), which facilitates takeover.

The root for conflicts of interest between target firm management and its shareholders is that management will often lose considerable control over company assets when a bid is successful (Okanigbuan 2013). This loss of control is generally due to management being made redundant by the new owner or more subtly the result of a more concentrated ownership structure implying a lower degree of management entrenchment. Currently, loopholes available to management are (1) pre-bid defences and (2) a lack of accountability in advisory functions.

The non-frustration rule only applies when a bid is received (Okanigbuan 2013). Consequently, mechanisms can be set in place by management before a bid is received with the intention to deter takeover attempts in the first place (Magnuson 2009, Okanigbuan 2013). E.g., golden parachutes at change of control generally make acquisitions more costly for the bidder (Okanigbuan 2013).[3] While staggered boards

[2]Dual share classes exist when a company issues shares with differing voting rights. Poison pills are tactics aimed at making the target shares undesirable for the acquirer, for example through shareholder rights plans or employee stock options. A board is staggered when its directors are elected at different term lengths. A golden parachute is the practice of granting key personnel the rights to considerable severance pay and the option to depart at change of control. Share buyback programs are schemes under which a company purchases its own shares at the market.

[3]As indicated above, golden parachutes can be adopted with shareholder approval in the UK.

are not regulated in takeover law, they are made ineffective in the Companies Act 2006, which states that shareholders can remove directors at any time (Okanigbuan 2013). Dual share classes are forbidden by LSE listing requirements (Sudarsanam 2003) and, outwith listing rules, would seldom find application due to a combination of necessity of shareholder approval and large institutional ownership, that would likely oppose dual share classes (Okanigbuan 2013).

The advisory role of management during the takeover process is not reviewed by an external body, which reduces accountability for the outcomes stemming from the advice given to shareholders. Simultaneously, the advice given might be highly influential on shareholder votes, thereby allowing for influence on the outcome of a bid without accountability (Clarke 2009, Okanigbuan 2013). An extension to this is the possibility of inviting white knights, which can serve to increase competition for the target, thereby increasing the purchase price or, if the price is driven up too far, might end the takeover bid altogether (Okanigbuan 2013). The Takeover Code aims to counter this by requiring the target company to hire an external advisor who gives independent advise to target firm shareholders (Burges Salmon LLP 2019).

1.5 Thesis Outline

The following three chapters present empirical studies of agency costs in UK takeover markets. Chapter 2 investigates the role of ARCH effects of bidding firm abnormal returns. Chapter 3 and Chapter 4 are takeover likelihood studies where the former focusses on general agency costs and the latter addresses agency costs of free cash flow. The concluding remarks are presented in Chapter 5.

Shareholders might opt to do so because they want to encourage takeover sucess once a bidder initiates an attempt. However, golden parachutes also incentivise management to conclude an acquisition regardless of price which might depress target shareholder returns.

Chapter 2

The Market Valuation of Mergers and Acquisitions in the UK — 1995 to 2014: Evidence from a GARCH Adjustment to Market Model Parameters

2.1 Introduction

The purpose of this chapter is to improve the understanding of abnormal returns accruing to bidding firm shareholders by refining the prevailing approach for evaluating stock price effects of Mergers and Acquisitions (M&A), i.e., event study methodology, on the basis of Ordinary Least Squares (OLS) (Brockett et al. 1999). Reflecting agency costs to bidding company shareholders, acquirer firm shares significantly underperform their benchmarks in the years following takeover announcements when expected returns are estimated using Market Model parameters (Dodd 1980, Franks & Harris 1989, Morck, Shleifer & Vishny 1990, Schwert 1996, Agrawal & Jaffe 2000, Walker 2000, Andrade, Mitchell & Stafford 2001, Capron & Pistre 2002, Martynova & Renneboog 2008). The use of OLS regression in financial research is commonplace despite recognised problems when modelling financial return data (Engle 2001). One such problem is that of Autoregressive Conditional Heteroscedasticity or ARCH effects, which may lead to inefficient estimation of model parameters. In such cases, ARCH effects should be modelled (Brooks 2014), which can, in turn, lead to mean equation coefficients that differ from OLS estimates (Armitage & Brzeszczynski 2011).

This chapter examines whether correcting model parameters for ARCH effects in the estimation period results improves Market Model parameters and results in a different interpretation of the effectiveness of Merger & Acquisition activity in the UK. Research using event study methodology with ARCH models is scarce. We identified three event studies using some form of Generalised ARCH (GARCH) based Market Models (De Jong, Kemna & Kloek 1992, Corhay & Rad 1996, Brockett, Chen & Garven 1999). However, none of these papers examine M&A. Therefore, we attempt to answer the following questions: (1) Are there ARCH effects when conducting M&A event studies in the UK? (2) Can models from the GARCH family help ameliorate the estimation problems of OLS when ARCH effects are present? (3) Are the resulting abnormal returns different from standard event studies when using ARCH models? and (4) Do these differences translate to variations in Cumulative Abnormal Return (CAR) cross-sectional models?

The term Market Model (MM) is used to describe a purely OLS-based event study and we introduce the term GARCH-Adjusted Model (GAM) for an event study where events with ARCH problems are modelled using GARCH. Notably, 50.76% of modelled events suffer ARCH effects. The range of GARCH models applied can correct all but 3.96% of total events. The MM seems to overestimate betas when ARCH effects exist, in turn leading to an overstatement of CAR negativity, which then leads to significant differences between the MM and GAM. The finding of agency costs in bidding firms remains intact but is corrected upwards (-20.09% in the MM vs. -15.95% when using the GAM over two years for the full sample).

This difference in CAARs translates to a disparity in shareholder value creation of £373.53mn for the average bidder. These differences, however, do not translate to significantly different coefficients in CAR prediction models.

Section 2.2 provides a literature review of abnormal returns to M&A and applications of GARCH models. The review concludes with a set of hypotheses. Section 2.3 provides an account of the methodology used for testing these hypotheses and is followed by an analysis of the resulting empirics in Section 2.4. A final section extends our concluding remarks.

2.2 Literature

2.2.1 M&A Abnormal Returns

Since Fama, Fisher, Jensen & Roll (1969) introduced and applied event study methodology, the approach has come to be the primary method for studying the effects of different events on asset returns (Brockett et al. 1999). Event studies observe the impact of an event on a variable. Usually, one aims to isolate the change in the variable due to the event from changes in the variable due to other factors. That isolated effect of an event can be termed the abnormal change of the variable. When applying this concept to finance, the variable of interest becomes the return on a company's share price and the event of interest is new (supposedly price-relevant) information that reaches the public. The isolated effect deriving from an event is then called abnormal (or excess) return. The Abnormal Return (AR) per period is the difference between the company's observed return and its would-have-been return in case the event does not happen.

The return that would have occurred without a takeover announcement can be calculated using a number of asset pricing models. The most commonly used approach is known as the Market Model, that is, the preceding relationship between a firm's stock and the market as a whole is used to derive an expected return series for the time around the event date. This return series is then estimated for a single period or cumulated over several periods. The magnitude of these abnormal returns and their statistical difference from zero is at the core of event study methodology.

With Fama often seen as the father of the efficient market hypothesis (Fama 1965, Malkiel & Fama 1970, Fama 1971), event study methodology is tightly integrated into the concept of efficient capital markets. This perspective has two implications: (1) Event study methodology assumes that financial markets efficiently change the price of an asset when new information reaches the market and (2) Asset returns are, on average, determined by their level of systemic risk as measured by beta. Note that whether the market reaction is rational is debated by behavioural finance scholars (see for example Barberis & Thaler 2003).

Examples of events in financial applications include changes in regulation (Binder 1985), central bank announcements, changes in accounting laws or, at a firm level, changes in accounting practices, and earnings announcements or surprises (Binder 1998), or in the case of Fama et al. (1969), stock splits.[1] By taking the announcement of corporate takeovers as the event of interest, the stock market reaction around the announcement date can be viewed as the market's short-term evaluation of the merger. M&A event studies focus on the share price reactions of bidding firms, target firms or both. While the focus of this chapter is on bidding firm shareholders, we also provide a brief overview of studies from two perspectives. In the case of a successful implementation of a merger with a favourable motive, we expect to observe positive abnormal returns in the bidding company i.e. value creation. In the case of value destroying takeover motives, we expect negative abnormal returns surrounding a takeover announcement.

On average, the shareholders of a target firm experience significant positive abnormal returns surrounding a merger announcement (Dennis & McConnell 1986, Servaes 1991, Schwert 1996, Mulherin & Boone 2000, Goergen & Renneboog 2004,

[1]A stock split is the practice to is to multiply the number of outstanding shares in a company by a specific factor with subsequent reissue to the company's shareholders proportional to their holdings.

Martynova & Renneboog 2008). These results can be explained by the market for corporate control hypothesis (Manne 1965, Jensen & Ruback 1983) in specific cases of disciplinary takeovers where mismanaged firms become takeover targets. A more general explanation can be derived from the bidding practice of paying a premium above current market price to target firm shareholders (DePamphilis 2010).

Abnormal returns accruing to bidding firms' shareholders around the announcement date are, on average, negative or not significantly different from zero (Dodd 1980, Morck et al. 1990, Schwert 1996, Agrawal & Jaffe 2000, Walker 2000, Andrade et al. 2001, Capron & Pistre 2002). Also, slight positive abnormal returns are observable in rare cases (Goergen & Renneboog 2004).

There are no significant differences between returns for domestic and international acquirers (Capron & Pistre 2002, Goergen & Renneboog 2004), which is often seen as evidence for the integration of international financial markets. Abnormal returns are significantly lower in hostile bids compared to friendly bids (Goergen & Renneboog 2004). Furthermore, bidding firms gain significantly higher abnormal returns in successful bids (Goergen & Renneboog 2004). Conversely, abnormal returns are especially negative when a bidder fails to complete a transaction (Bradley, Desai & Kim 1988).

Surprisingly, Travlos (1987) did not find a significant relationship between the premium paid in an acquisition and bidder abnormal returns. On the contrary, Hackbarth & Morellec (2008) have reported negative abnormal bidder returns when higher premiums are paid and the bidder carries a low level of debt. Bidding firms gain significantly more when paying with their stock compared to all-cash offers (Chang 1998, Agrawal & Jaffe 2000, Black, Carnes & Jandik 2001, Shleifer & Vishny 2003, Goergen & Renneboog 2004, Megginson, Morgan & Nail 2004). There is a range of evidence for higher abnormal returns when the acquisition target is an unlisted firm (Moeller, Schlingemann & Stulz 2005, Faccio, McConnell & Stolin 2006, Capron & Shen 2007, Poulsen & Stegemoller 2008).

When acquiring targets from unrelated industries, bidders typically accrue lower returns compared to horizontal or vertical acquisitions (Campa & Kedia 2002, Villalonga 2004). This observation is closely related to the diversification discount present in companies active in multiple industries (Berger & Ofek 1995, Lins & Servaes 1999). Goergen & Renneboog (2004) observe a negative effect of bidding firm diversification on abnormal returns, regardless of the diversification effect of the current acquisition. DeLong (2001) and Graham, Lemmon & Wolf (2002) present evidence for higher returns in horizontal acquisitions. These findings provide empirical support for the existence and recognition of economies of scale and scope, as well as the possibility of increased pricing power in more concentrated markets.[2] Somewhat related to this is the importance of availability of suitable merger partners for acquisition success (Haspeslagh & Jemison 1991, Angwin 2000).[3]

There is evidence for lower takeover intensity for industries with a low Herfindahl Index, a measure for industry concentration (Andrade & Stafford 2004). Bao & Edmans (2011) report a non-significant effect for the Herfindahl Index on short-term CARs. Aktas, De Bodt & Roll (2010) control for industry concentration without showing results.

Takeover activity is cyclical so that waves of higher takeover intensity are observable (Martynova & Renneboog 2008, DePamphilis 2010). Aktas et al. (2010) have demonstrated that increased takeover intensity leads to higher premiums paid in acquisitions. Related to this, Lambrecht (2004) hypothesise that takeover activity should be higher in times of economic expansion.

Due to hubris (Moeller et al. 2004, 2005) and empire building (Gorton, Kahl & Rosen 2009), larger corporations can accrue smaller abnormal returns than smaller market participants, though at least one study reported non-significant findings (Franks & Harris 1989). When examining the relative size difference between bidder and target, the evidence is mixed. Hackbarth & Morellec (2008) find a negative

[2] Economies of scale refer to the ability to accrue higher profits with higher volume where fixed costs are high. Economies of scope allow for higher profitability through knowledge effects.

[3] We import proxies of merger partner availability from the takeover likelihood literature (see Chapters 3 and 4). Next to benefits from choosing a fitting target we hypothesize that availability of more potential targets leads to a negotiation advantage which should protect from overpayment.

effect of relative size on one- and two-year CARs. Travlos (1987), Chang (1998), Capron & Pistre (2002) and Goergen & Renneboog (2004) reported no significant effect for relative size, while Danbolt, Siganos & Vagenas-Nanos (2015) reported a significant positive effect on short-term CARs.

In line with international results, empirical evidence for UK acquirers suggests negative or non-significant abnormal returns for UK acquirers. Franks & Harris (1989), Limmack (1991) and Higson & Elliott (1998) reported zero Average Abnormal Returns (AAR) and Sudarsanam, Holl & Salami (1996), Sudarsanam & Mahate (2003) and Antoniou et al. (2008) concluded negative bidder abnormal returns. Additionally, some UK studies have demonstrated positive short-term Cumulative Average Abnormal Returns (CAAR) (Conn, Cosh, Guest & Hughes 2005, Danbolt et al. 2015, Giannopoulos, Khansalar & Neel 2017).

Combined firm studies are rare. However, Servaes (1991) and Martynova & Renneboog (2008) demonstrated that the combined firm, i.e., the total equity market values of bidder and target gain positive abnormal returns following a merger announcement. Goergen & Renneboog (2004) come to the same conclusion under the condition of the potential for synergies. Combined firm gains are significantly higher for takeovers occurring at the start of a takeover wave (Harford 2005, Bhagat, Dong, Hirshleifer & Noah 2005, Moeller et al. 2005).

Finally in this section, the percentage of equity acquired in a takeover has been shown to have a weak positive effect on long-term CARs (Hackbarth & Morellec 2008).

Table 2.1 summarises variables, provided they are readily available for us, from Sections 2.2.1 and 3.2.2 and their corresponding literature. Some of the studies, especially from the literature on agency costs are not on bidding firm abnormal returns and we imply their hypothesised sign under the premise that higher agency costs lead to lower abnormal returns (see Chapter 3, especially Section 3.2.2).

Table 2.1: Previous literature

Panel A: Deal characteristics	Study (Year)	Effect on bidding firm CARs
Relative deal value	Danbolt, Siganos & Vagenas-Nanos (2015)	Positive
	Hackbarth & Morellec (2008)	Negative
	Travlos (1987), Chang (1998), Capron & Pistre (2002), Goergen & Renneboog (2004)	Non-significant
Diversifying acquisition	Campa & Kedia (2002), Goergen & Renneboog (2004), Villalonga (2004)	Negative
Availability of merger partners	Haspeslagh & Jemison (1991), Angwin (2000)	Positive
Percentage acquired	Hackbarth & Morellec (2008)	Positive
Panel B: Agency cost indicators		
Valuation	Yermack (1996), Doukas, Kim & Pantzalis (2000), Gompers, Ishii & Metrick (2003), Coles, Daniel & Naveen (2008), Hackbarth & Morellec (2008)	Positive
	Sudarsanam & Mahate (2003), Bao & Edmans (2011)	Negative
Profitability	Gompers, Ishii & Metrick (2003), Coles, Daniel & Naveen (2008), Bao & Edmans (2011)	Positive
Sales growth	Gompers, Ishii & Metrick (2003), Loderer & Waelchli (2015)	Positive
	Doukas, Kim & Pantzalis (2000), Powell & Yawson (2007)	Non-significant
Cost- and sales efficiency	Yermack (1996), Ang, Cole & Lin (2000), Singh & Davidson III (2003), McKnight & Weir (2009)	Positive
Indebtedness and debt capacity	Jensen (1986), McKnight & Weir (2009), Hackbarth & Morellec (2008)	Positive
	Bruner (1988), Nuttall (1999)	Negative
	Dickerson, Gibson & Tsakalotos (2002), Loderer & Waelchli (2015)	Non-significant
Dividend payments	Jensen (1986)	Positive
	Barnes (2000), Dickerson, Gibson & Tsakalotos (2002)	Non-significant
CAPEX	Dickerson, Gibson & Tsakalotos (2002)	Positive
	Jensen (1986)	Negative
	Yermack (1996)	Non-significant
Firm size	Yermack (1996), Doukas, Kim & Pantzalis (2000), McKnight & Weir (2009)	Positive
	Moeller, Schlingemann & Stulz (2004, 2005), Gorton, Kahl & Rosen (2009)	Negative
	Franks & Harris (1989)	Non-significant
Panel C: Environmental factors		
Takeover intensity	Martynova & Renneboog (2008), Aktas, De Bodt & Roll (2010), DePamphilis (2010)	Negative
Industry concentration	Andrade & Stafford (2004)	Positive
	Bao & Edmans (2011)	Non-significant
Economic growth	Lambrecht (2004)	Negative

Notes: The table details variables used in our models for coefficient difference testing and indicates references to previous research. Panel B shows variables that are not necessarily present in previous studies of bidding firm cumulative abnormal returns, but are proxies of agency costs, which are included here to conform to the approach in this thesis to study agency costs in takeover markets. This part of the table is heavily influenced by the variables identified in Chapter 3. See Table A.1 in Appendix A for variable names and definitions.

2.2.2 GARCH Applications

One of the statistical properties of financial return data is that volatility appears in clusters, meaning the volatility of financial asset returns is autocorrelated. While asset returns are not related, they are serially dependent (Cont 2001). When financial returns are used as the dependent variable in an OLS regression, volatility clusters are transferred to the variance of the error term. What follows is an unequal variance of the error term, which is called heteroscedasticity (Engle 2001). Using OLS in the presence of heteroscedasticity leads to faulty model standard errors. Consequently, many diagnostic tests cannot be applied with confidence and the estimators do not serve the minimum variance property, meaning there is another more efficient estimator (Hill, Griffiths & Lim 2012).

Models in the ARCH family target both problems by adding an equation for the error term variance and, in the process, correcting the estimator of the explanatory variable (Tsay 2005, Brooks 2014). In practice, the most commonly used model from the ARCH family is generalised ARCH (GARCH), developed by Bollerslev (1986, 1987).

The first application of ARCH in empirical research was the study of volatility spillovers and autocorrelation, dubbed meteor showers and heat waves, in relation to market efficiency. Engle et al. (1990) applied ARCH to demonstrate that there is a considerable spillover of volatility from one market to another.

Although more complex and difficult to use, GARCH models are widely applied in financial research and practice (Engle 2001), in particular, concepts that use an asset's volatility as an input benefit from considering conditional heteroscedasticity (Tsay 2005). However, models that use the conditional variance as an explanatory variable in the mean equation (e.g., GARCH in mean) and return forecasts on the basis of the Market Model or Capital Asset Pricing Model (CAPM) can be significantly improved (Brooks 2014). We find only a limited number of studies have applied a GARCH adjustment in event studies to date. Brockett et al. (1999) examined the announcement of a referendum on insurance regulation, whilst Corhay & Rad (1996) studied divestiture announcements.

An early attempt to build a GARCH-based option pricing model was carried out by Duan et al. (1995) which was later refined by Barone-Adesi, Engle & Mancini (2008). Several shortcomings of the Black-Scholes Model, such as mispricing, can be overcome by including GARCH results in the options calculation. This solution is achieved by having a more reliable and dynamic input for the implied volatility of an option.[4]

Several authors have demonstrated that it is possible to produce more reliable Value at Risk (VAR) results when using GARCH as an input. For example, So & Philip (2006) have demonstrated how to incorporate GARCH when determining the VAR for indices and foreign exchange rates. Berkowitz & O'Brien (2002) describe how a combination of ARCH and Autoregressive Moving Average (ARMA) could lead to VAR exceeding the reliability of most VAR models employed in commercial banks.[5]

Many authors have also successfully incorporated ARCH corrections into the calculation of optimal hedge ratios. One example is the application of a GARCH-based hedge ratio for Australian futures on equities in a sample from 1992 to 2002, where a conditional hedge ratio was developed that is notably stronger than OLS when used on an out-of-sample test (Yang & Allen 2005). The need for a conditional hedge ratio has also been demonstrated on a commodity market sample (Moschini & Myers 2002).

A paper of crucial importance for this study is Armitage & Brzeszczynski (2011), which reveals that CAPM betas derived from GARCH deviate from OLS betas by absolute values of up to 0.25%. In out-of-sample forecast tests, ARCH style betas did not outperform the OLS betas reported in Schwert & Seguin (1990) and Fraser, Hamelink, Hoesli & Macgregor (2004). Notably, Braun, Nelson & Sunier (1995),

[4]The Black-Scholes Model is a probabilistic method for valuing stock-options.

[5]A firm's VAR is the amount of value it might lose under a set of assumptions within a certain amount of time.

Brooks, Faff, McKenzie & Ho (2000) and Lie, Brooks & Faff (2000) found almost perfect positive correlations between OLS and ARCH/GARCH betas.

Brockett et al. (1999) have stated that it is possible to include GARCH results in event study methodology and suggest calculating expected returns incorporating the effects of ARCH and time-varying beta. The model was tested with a critical law passage influencing insurance companies. Crucially, the findings contest previously held assumptions about the effect of the law announcement of interest and demonstrate that event studies neglecting the influence of conditional heteroscedasticity can be misleading.

Corhay & Rad (1996), in a study of corporate divestiture announcements, compared abnormal returns resulting from an OLS-based Market Model with abnormal returns from a GARCH model of the order (1,1). Findings revealed that daily average abnormal returns are not significantly different between models for any event day from -20 to +20. We apply a methodology similar to that of Corhay & Rad (1996) but extend their simplistic results by analysis of differences in parameter estimation and their subsequent effect on cross-sectional significance.

The preceding literature leads us to identify the following hypotheses for testing:

Market efficiency and the unpredictability of the arrival of price-sensitive information lead to volatility clustering in financial return series. Such volatility clusters are likely to lead to ARCH effects when applying event study methodology based on OLS (Engle 2001). Accordingly the first hypothesis is

H_1: There are ARCH effects in OLS-based event studies.

As an empirical observation (but not a mathematical necessity) betas are diverging from an OLS estimate when correcting ARCH effects using GARCH (Armitage & Brzeszczynski 2011). In the context of an event study, such differences in beta will translate to different expected returns, which in turn will lead to different abnormal returns (De Jong et al. 1992, Corhay & Rad 1996, Brockett et al. 1999). Thus,

H_2: GAM abnormal returns are significantly different from MM abnormal returns.

Correcting for ARCH effects will not affect the underlying economics of value creation in M&A (Dodd 1980, Franks & Harris 1989, Morck et al. 1990, Schwert 1996, Agrawal & Jaffe 2000, Walker 2000, Andrade et al. 2001, Capron & Pistre 2002, Martynova & Renneboog 2008). Mainly as a result of implicit or explicit competition between bidding firms,

H_3: Bidding firm GAM abnormal returns are negative or not significantly different from zero.

Finally, if abnormal returns from the GAM are different from those generated by the MM, it can be expected that cross-sectional models using these different values as the dependent variable will find, that

H_4: Coefficients of CAR predictors differ between GAM estimation and MM estimation.

The variables for prediction modelling in H_4 are listed in Table 2.1 together with their (implied) signs from previous literature.

2.3 Data Set and Methodology

2.3.1 Data Set

The UK takeover market was selected for testing because it is considered to have an active market for corporate control (Sudarsanam 2003). In an active market for corporate control, the takeover market is used for disciplining corporate management by facilitating corporate takeovers. That is, such a market has low restrictions on

M&A activity, and thus experiences high takeover activity (Jensen & Ruback 1983). The UK market also has only very restricted anti-takeover provisions and is amongst the most open global markets for M&A. Dual class shares are prohibited (at the time of writing) and corporate ownership is amongst the most dispersed among all financial markets (see Section 1.4). This environment makes the UK an ideal sample market for our analyses.

Takeover data was sourced from Thomson ONE Banker. We required the acquirer nation to be United Kingdom and the acquirer public status to be Public. We did require an acquirer market capitalisation of at least one billion GBP and considered acquisitions announced between 01/01/1995 and 31/12/2014. Only successful acquisitions were included. Stock price data for each event was loaded from DataStream. If there were two events for the same company on a given date, we treated them as one event for univariate analysis. The *FTSE All share* was used as a proxy for the market portfolio.

Thomson ONE Banker lists takeovers with deal values in United States Dollars (USD). Deal values were translated to Pound Sterling (GBP) by the USD/GBP exchange rate on the announcement date as stated by the Bank of England. Where the announcement date fell on a non-trading day, we used the next available trading day. We implemented both adjustments for a maximum of seven calendar days. For our data set, this rule did not result in any event exclusions.

For the main analysis, the data set was restricted to contain acquisitions where at least 50% of target firm equity was held by the bidder after the transaction. Also, the relative value of the transaction to bidding firm market capitalisation was required to be at least 1%. Both rules were implemented to ensure that the transactions in the sample were acquisitions of control with material impact on the acquirer's business, as opposed to foothold acquisitions (Moeller et al. 2004, Danbolt et al. 2015).

The most recent available accounting data were matched with the event set using the financial year end date for cross-sectional modelling. Where the date was missing, it was inferred from other available years, or, if that failed, was assumed to be the 31st of March of that year, in line with Her Majesty's Revenue and Customs (HMRC) standard. Market-value-based data were used on the day of the event. Both accounting and market value data were sourced from DataStream. All cross-sectional variables were winsorised at 0.5% on both sides to prevent potential outlier issues. Financial services firms and utilities firms were excluded from cross-sectional analysis.

2.3.2 Event Study Methodology

Abnormal return was calculated using event study methodology. A one-day abnormal return refers to the difference between the company's observed return and its expected or benchmark return in case a merger does not happen, which is calculated as follows:

$$AR_{i,t} = r_{i,t} - E(r_{i,t}) \tag{2.1}$$

where $AR_{i,t}$ denotes the abnormal return for company i on event day t, $r_{i,t}$ is the realised return for company i on event day t, and $E(r_{i,t})$ is the expected return for company i on event day t. The expected return $E(r_{i,t})$ that would have occurred without a takeover announcement is calculated using the Market Model:

$$E(r_{i,t}) = \alpha_i + \beta_i r_{m,t} \tag{2.2}$$

where α_i is company i's intercept, β_i is company i's beta with the overall market and $r_{m,t}$ is the market return on event day t. The coefficients were estimated based on trading data before the event windows of interest to exclude possible effects of pre-merger information leakage and diminish other extraordinary events' effects on the stock price. In our case, the lowest boundary of all event windows was -30 trading days. Maintaining a gap of 20 trading days, we used the set of returns from 230 to 50 trading days before the event for our estimations.

Market Model alphas and betas are estimated using OLS. Omitting the firm-specific subscript i, our first model was defined as follows:

$$r_t = \alpha + \beta r_{m,t} + u_t \tag{2.3}$$

where it is assumed that the error term u_t is normally distributed with zero mean and constant variance, serially uncorrelated and independent.

The results from OLS modelling provide the foundation for the GARCH-corrected event study (GAM). We test each event for ARCH effects using Engle's (1982) test for autoregressive conditional heteroscedasticity. With the residuals from an event's OLS Market Model as the dependent variable, we estimate:

$$\hat{u}_t^2 = \gamma_0 + \sum_{q=1}^{Q} \gamma_q \hat{u}_{t-q}^2 + \upsilon_t \tag{2.4}$$

The statistic of interest here is $R^2 \times N$, which follows a χ_q^2 distribution. The null hypothesis is $\gamma_0 = \gamma_1 = \ldots = \gamma_q = 0$, so that a significant test indicates ARCH effects. We tested for all $\{q \mid q \in \mathbb{N}, q \leq 5\}$.

If a test for ARCH effects was significant at the 95% level for any lags ≤ 5, we ran a range of GARCH models on the same data until the ARCH tests were non-significant. In each case the first GARCH model under consideration was GARCH of the order (1,1). If that approach failed to sufficiently model ARCH effects, we dropped the results and modelled an Exponential GARCH (eGARCH) of the same order. If this also failed, we dropped the exponential GARCH results and estimated a Threshold GARCH (tGARCH) of the order (1,1). If none of these GARCH models returned non-significant ARCH tests for all lags, we defined the event as Uncorrectable and removed it from the OLS study. The results consisting of ARCH-free OLS results and GARCH-corrected Market Models were labelled Corrected in the results section.

GARCH models the return series as a simultaneous estimation of Equation 2.3 and

$$u_t = \sigma_t \epsilon_t \tag{2.5}$$

$$\sigma_t^2 = \gamma_0 + \gamma_1 u_{t-1}^2 + \gamma_2 \sigma_{t-1}^2 \tag{2.6}$$

ϵ is an iid random variable with an assumed Student's t-distribution of zero mean and variance of 1, where the degrees of freedom are part of the estimation process. Also, γ_1 can be referred to as the ARCH(1) parameter while γ_2 is termed the GARCH(1) parameter (Bollerslev 1986). We opted for t-distributed innovations in line with Tsay (2005) and the recommendations set by the author of R's univariate GARCH package (Ghalanos 2015).

In tGARCH, the conditional volatility is estimated as:

$$\sigma_t^2 = \gamma_0 + \gamma_1 u_{t-1}^2 + \gamma_2 \sigma_{t-1}^2 + \gamma_3 u_{t-1}^2 I_{t-1} \tag{2.7}$$

where I_{t-1} is a binary variable that is 1 when $u_{t-1} < 0$. As a result,γ_3 captures sign effects.

In an eGARCH, the variance equation is as follows:

$$\ln\left(\sigma_t^2\right) = \gamma_0 + \gamma_1 \left[\frac{|u_{t-1}|}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}}\right] + \gamma_2 \ln\left(\sigma_{t-1}^2\right) + \gamma_3 \frac{u_{t-1}}{\sqrt{\sigma_{t-1}^2}} \tag{2.8}$$

Again, possible asymmetry effects are captured in γ_3. In both eGARCH and tGARCH, we assumed the innovations to be skewed Student's t-distributed.

The GARCH models were selected to closely resemble the original Market Model. ARMA or GARCH in mean models were not considered for event studies because we calculate the expected return without a merger happening. Using ARMA or GARCH in mean results in the event predicting itself.

We use a third, rather simplistic method for determining abnormal returns by allowing a day's abnormal return to be the difference between the individual company and market return for that day:

$$AR_{i,t} = r_{i,t} - r_{m,t} \tag{2.9}$$

This model is commonly referred to as the Index Model (IM) or market-adjusted returns. An alternative description of this model is the zero-one model due to α_i being fixed at 0 and β_i at 1 for all i.

The purpose of an event study is to observe the behaviour of abnormal returns around the event day. Summing daily abnormal returns leads to cumulative abnormal returns:

$$CAR_{i,(t_1,t_2)} = \sum_{t=t_1}^{t_2} AR_{i,t} \tag{2.10}$$

where $CAR_{i,(t_1,t_2)}$ is the cumulative abnormal return for company i in the event window t_1 to t_2. Using the day of the takeover announcement as event day 0, t_1 and t_2 are expressed in the number of days' distance to the takeover announcement. For example, a day before the takeover announcement is -1 and one day after the announcement is +1.

An event day t's average abnormal return (AAR_t) is the arithmetic mean of all observed transactions' abnormal return for that event day:

$$AAR_t = \frac{1}{N}\sum_{i=1}^{N} AR_{i,t} \tag{2.11}$$

AARs were examined for event days -5 to 5 to detect short-term market movement closely around the event day. Since such daily changes can be expected to be miniscule we were also interested in aggregating AARs into short-term and long-term event windows. Taking the sum of average abnormal returns for the event window t_1 tot_2 returns the cumulative average abnormal return ($CAAR_{t_1,t_2}$) across all observed transactions:

$$CAAR_{t_1,t_2} = \sum_{t=t_1}^{t_2} AAR_t \tag{2.12}$$

A wide range of short-term windows was applied to observe the entire reaction of investors to takeover announcement up to two weeks starting with the event day: 0 to 1, 0 to 2, 0 to 5 and 0 to 10. Similar short windows but including pre-event days were examined to capture possible information leakage: -2 to 0, -2 to 2, -3 to 3, -5 to 5 and -5 to 10. A range of mid-term windows was used to estimate the value creation after all deal relevant information, including potential additional disclosures and post deal announcement were incorporated (-10 to 10, -20 to 20, -30 to 30 and -50 to 50). A pre-event window was tested to verify that there was no significant price-movement in the mid-term run-up to the event (-60 to -3).

The long-term effects of M&A were analysed to include information on post-merger integration success and realisation of strategic and financial objectives of the transaction. Here we exclude the event day itself in order to remove the announcement effect itself and focus the arithmetic on the post-integration success: 3 to 60, 3 to 130, 3 to 260 (one year) and 3 to 520 (two years). While it can be argued that buy-and-hold abnormal returns should be used to estimate long-term merger success (Barber & Lyon 1997), we follow Hackbarth & Morellec (2008) and Franks & Harris (1989) in their assumption that cumulation is a valid proxy for compounded abnormal returns.[6]

We test abnormal and cumulative abnormal returns resulting from the OLS (MM), GARCH-corrected (GAM) and Index Model (IM)-based studies for statistical difference using paired samples t-tests. For each pair, the null hypothesis was equal (cumulative) abnormal returns for both studies. For the main results, ARs and CARs are left unwinsorised. To ensure that results are not driven by outliers, tests of CAARs were repeated on basis of winsorised CARs, with a degree of 0.5% on both sides, in Subsection 2.4.6.[7]

2.3.3 Cross-Sectional Analysis and Coefficient Difference Testing

We estimated OLS models with industry-year dummies using (a) short-term abnormal returns from t_0 to $t_1 0$ and (b) long-term abnormal returns from t_3 to $t_5 20$ as the dependent variables. The windows have been selected by repeating the regression detailed in Equation 2.13 for all calculated event windows (see for example Table 2.4) and subsequently identifying one short window and one long window based on maximising the number of significant coefficients. Other windows were examined to confirm consistency. For both times windows, we modelled the same regression based on the three different AR estimation methods in succession:

$$CAR_i = \alpha + \beta_1 x_i + \beta_2 y_i + \beta_3 y_i + \epsilon \tag{2.13}$$

where CAR_i is the cumulative abnormal return for event i, x is a vector of deal-specific variables, y is a vector of bidder-specific variables and z is a vector of micro- and macro-environment variables, α and β_1 to β_3 are vectors of parameters to be

[6]Note that Franks & Harris (1989) calculate CARs on basis of monthly returns.

[7]OLS regressions were estimated using the Python package statsmodels, version 0.6.1. Univariate GARCH models were estimated using the R package rugarch, version 1.3-6 on R 3.2.2 (R Core Team 2015, Ghalanos 2015). t-test functionality from the python package scipy version 16.0 was also used.

estimated with α being the constant and ϵ is the error term.

The coefficients from the resulting models were tested for difference using a standard z-score approach:

$$z = \frac{\beta_x - \beta_y}{\sqrt{SE_x^2 + SE_y^2}} \tag{2.14}$$

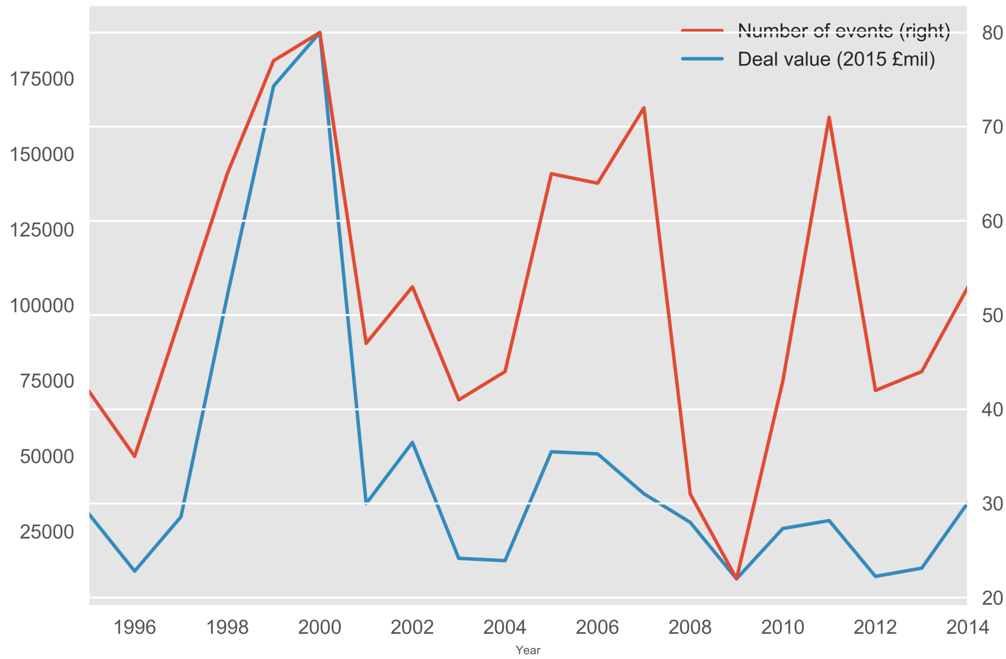
The significance of the test statistic is assessed as a two-tailed test.

2.4 Results and Discussion

2.4.1 Descriptives

Figure 2.1 illustrates the number of acquisitions and total deal value acquired per year. M&A activity peaks in 1999, just before the burst of the dot-com bubble (the collapse of equity prices after 2000), both in terms of deal count and acquired value. Further high marks in number of deals, are in 2007, before the 2008 financial crisis, and in 2011, the recovery after the financial crisis. These peaks are surrounded by phases of low activity. Such cyclical patterns are typical for M&A data (DePamphilis 2010).

Event descriptives are listed in Table 2.1. The final sample comprises 1,041 events; the first being announced on the 03/01/1995 and the last on 24/12/2014. Deal values range from £11mn to £65bn with a mean of £911mn. Conforming to the inclusion criteria, the smallest bidder has a market capitalisation of £1bn at announcement, and the largest acquirer is valued at £176bn. The average deal is 10% of the acquirer's market cap and ranges from 1% to more than double the market cap of the acquirer. The average acquirer took over 20 companies throughout the period of observation. 30% of all acquisitions were within the same industry and a mean of 96% of target equity was owned after acquisition in our sample.



The figure shows deal value acquired per year (blue line, scale on the left y-axis) and number of deals per year (red line, scale on right y-axis). Deal values are in 2015 million GBP.

Figure 2.1: Number of deals and deal value per year

Table 2.2: Descriptives of deal characteristics

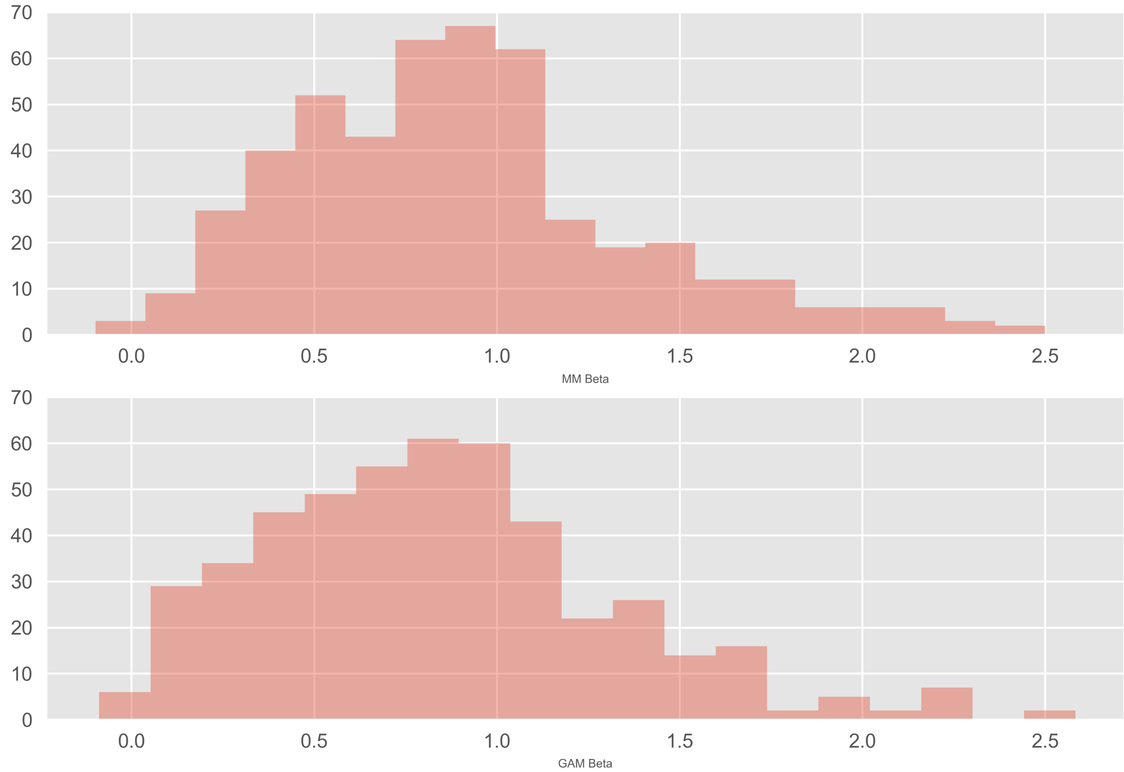
	N	mean	std	min	median	max
ex post takeover count	226	20.2876	30.9741	1	10	295
event date	1041			1995-01-03		2014-12-24
deal value	1041	910.9569	3380.0080	10.9964	165.6710	64 751.6063
market cap	1041	9.0224	17.1443	1.0255	3.4871	175.9216
rel deal value	1041	0.1040	0.2029	0.0101	0.0344	2.1681
pct owned after transaction	1041	0.9615	0.1143	0.5000	1.0000	1.0000
same industry	1041	0.3026	0.4596	0.0000	0.0000	1.0000

Notes: The table shows descriptive statistics for the deal characteristics in the final sample. Ex post-takeover count is the total number of acquisitions per acquirer during our period of observation. Event date is the announcement date of an acquisition. Deal value is the value of the acquisition in million British Pound (2015). Market Cap is the market value of the acquirer's equity on the acquisition date in billion British Pound (2015). Rel deal value is deal value as a ratio of acquirer market cap. Pct acquired is the percentage of the target's equity acquired. Same industry is a dummy that is 1 when the acquirer and target have the same 4-digit SIC code.

2.4.2 ARCH Effects and Corrections

ARCH effects were detected in several events. The data set criteria defined in Section 2.3, before enforcing limitations on relative deal value and percentage owned after acquisition, resulted in an initial set of 4,039 takeovers. An OLS-based Market Model was modelled for each acquisition and if the OLS model produced evidence of ARCH effects, a GARCH-corrected version of the same event was modelled (the GAM model). There was no evidence of ARCH effects in 1,989 cases of OLS-based Market Models. In 1,324 cases, a standard GARCH(1,1) model was sufficient for modelling the ARCH effects. From the remaining events, a further 506 events could be modelled by an eGARCH(1,1). Of the remaining 220 events, 60 were modelled as tGARCH(1,1). The remaining 160 events revealed significant evidence of ARCH effects for all attempted models. These events were subsequently classified as uncorrectable and were omitted from the sample. The final data set thus contains 3,879 events. With almost half of the events receiving GARCH adjustment, the following analysis examined the effect of the effect of GARCH modelling on beta values. These results were robust to the implementation of relative size and percentage-owned limitations. The sample size decreased to 1,041 with 54% modelled through OLS, 32% using GARCH, 13% using eGARCH and 1% tGARCH.

Individual betas may not differ substantially between estimation methods. Figure 2.2 presents a comparison of distributions of OLS- and GARCH-based betas for each event receiving a GARCH correction. Differences between beta distributions are barely discernible; a phenomenon that is amplified when events not needing correction are added, as in Figure 2.3. In both cases, however, adjusting for GARCH seems to move notably high OLS betas towards the mean of the distribution. This visual observation is reflected in a positive mean difference between Market Model and GARCH-Adjusted Model betas that is highly significant in a t-test (see subcaptions of Figure 2.2 and Figure 2.3). It is questionable whether this positive mean difference translates into significantly different abnormal returns. Both figures emphasise that it is not sufficient to examine beta differences alone since materiality



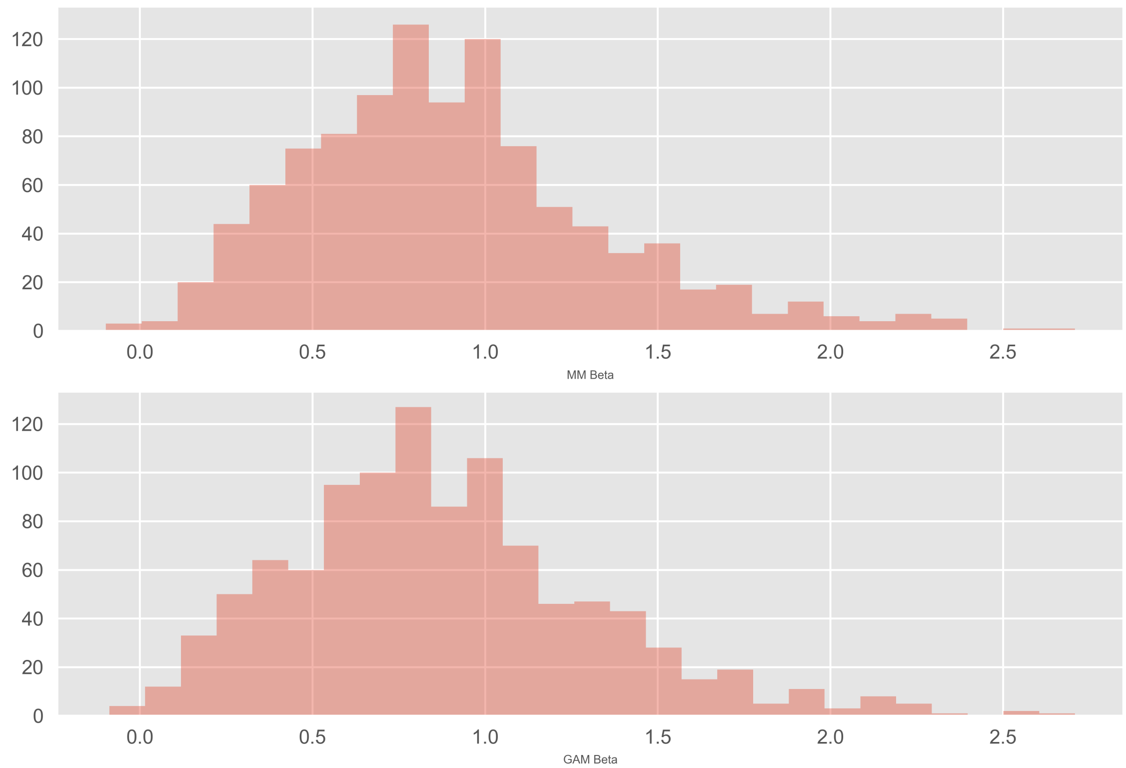
The figure shows a histogram of betas from the Market Model at the top and a histogram of betas from the GARCH-Adjusted Model at the bottom. The sample is the subset of corrected events only. N = 478 with mean difference for MM Beta - GAM Beta = 0.0570***, std = 0.1245 and p < 0.0000 for t-test = 10.0050

Figure 2.2: Beta histograms Market Model vs. GARCH-Adjusted Model, corrected events only

of the adjustment depends on subsequent estimation of expected and abnormal performance.

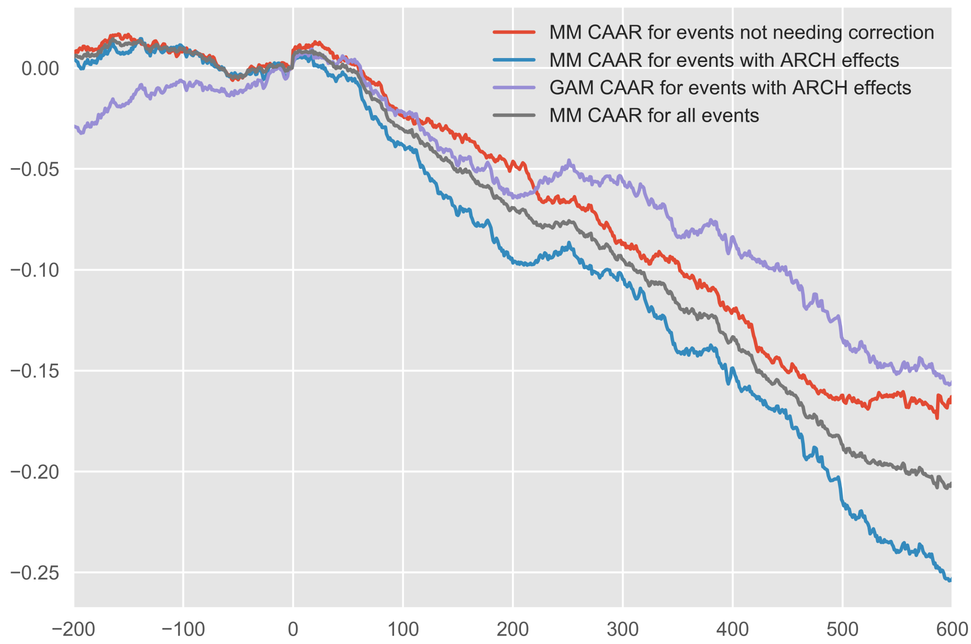
CAARs differ substantially when corrected and uncorrected events are compared. Figure 2.4 displays CAARs for all events not needing a GARCH correction (red line), CAARs for events with ARCH problems on the basis of the uncorrected Market Model (blue line), the GARCH-corrected equivalent (purple line) and the average of all events using the Market Model (on the grey line). Events with ARCH problems display more volatile CAARs, regardless of their correction.[8] The autoregressive nature of their volatility appears to persist past the estimation period. The GARCH correction shifts the CAAR line closer to the average for events where correction is not necessary. Over the course of 600 trading days, ARCH-affected events display higher returns than when no ARCH effects were detected, when GARCH-adjustment is used.

[8]The GARCH models' volatility equation does not feed into the calculation of expected returns.



The figure shows a histogram of betas from the Market Model at the top and a histogram of betas from the GARCH-Adjusted Model at the bottom. The sample is the full sample. N = 1041 with mean difference for MM Beta - GAM Beta = 0.0262***, std = 0.0890 and p < 0.0000 for t-test = 9.4868

Figure 2.3: Beta histograms Market Model vs. GARCH-Adjusted Model, full sample



The graph plots CAARs for the subsamples of events with and without ARCH problems. For the subset with ARCH problems, both the Market Model and the GARCH-Adjusted Model are depicted. The aggregation of all events when using the Market Model is provided in grey.

Figure 2.4: Subparts of the Market Model and GARCH-Adjusted Model CAARs

Finding ARCH effects was not surprising as the presence of ARCH in financial return series with daily frequency is well established (Engle 2001). However, it was unexpected that the amount was not higher. It was instructive to observe that GARCH(1,1) was sufficient in most cases. We did not opt to increase the number of p,q parameters or move to more sophisticated methods (e.g., multivariate GARCH) because the improvement in models would be negligible, that is, only 3.96% percentage of events are excluded.[9]

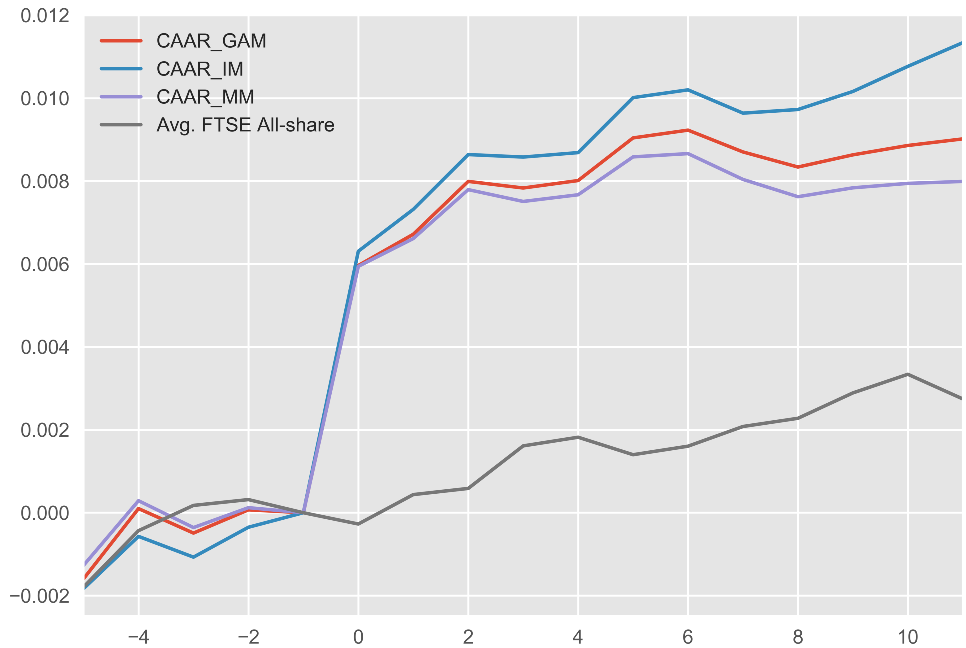
2.4.3 Event Study

We now consider the issue for short- and long-term shareholder wealth effects and introduce a comparison of Abnormal Returns (ARs) estimated with different expected return generating mechanisms. This comparison was conducted by plotting short- and long-term CAARs for the full sample and statistical analysis of AARs and CAARs from different models on the basis of the full and corrected subsamples.

Plotting short-term CAARs from different estimation methods for the full sample reveal a positive reaction to takeover announcements on the event day and emphasise negative post-announcement returns. Figure 2.5 depicts CAARs per estimation method and cumulative average market returns (r_m) for the period t_{-5} to t_{11}. All returns are based at 0 on t_{-1}. A clear jump in CAAR is visible at t_0 for all estimation methods. The average market movement is consistently positive with very little short-term cyclical behaviour. In this short-term examination, all three estimation methods depict a steady increase, roughly in line with the average market movement after the initial jump at t_0. After 11 trading days, Index Model CAARs are highest, Market Model CAARs are lowest, with GARCH-Adjusted Model CAARs in between.

Daily average abnormal returns per estimation method for the full sample are listed in Panel A of Table 2.3. There was significant positive movement on event

[9] 3.96% is before the implementation of relative deal value and percentage of equity owned after the transaction.



CAARs were calculated on the basis of the full sample. MM is Market Model, IM is Index model and GAM is GARCH-Adjusted Model. Average market returns are added for comparison. Event days are on the x-axis and CAARs are on the y-axis.

Figure 2.5: CAARs for event window -5 to +11

days t_{-4}, t_0, t_2 and t_5 for all three modelling techniques. A positive abnormal return of 0.6% was observed on t_0, which is markedly larger in magnitude than all other abnormal returns in Table 2.3. There are no significant negative AARs across the days t_{-5} to t_5.

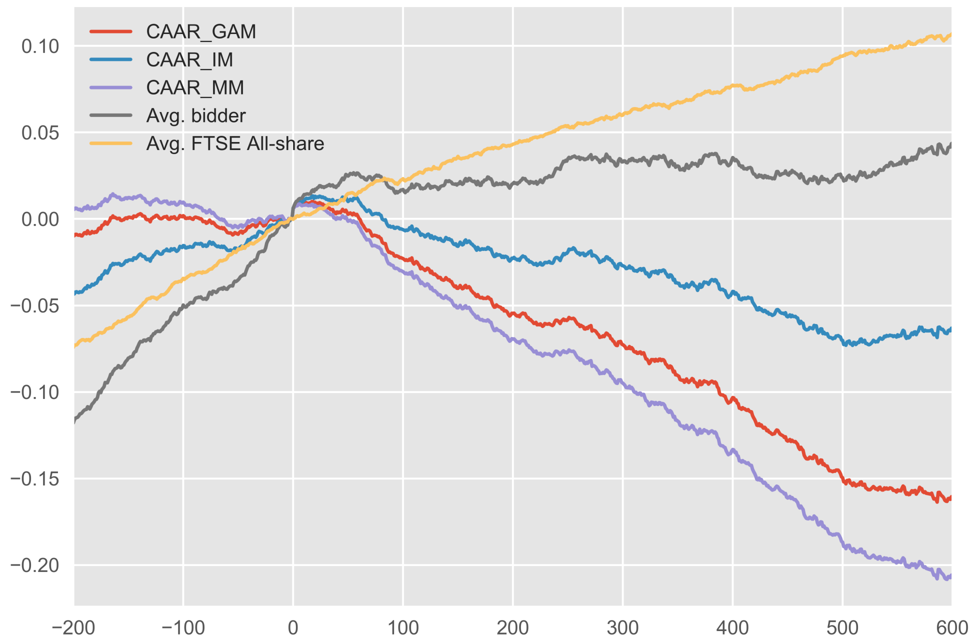
Results are not as clear for the subsample of events where GARCH correction was necessary (Panel B). AARs on the event day are only positive for the Index Model but not significant for MM and GAM. The only congruence with Panel A is the significant positive effect on t_{-4} for all models which may be indicative of information leakage.

A graphical analysis of long-term CAARs exposed negative returns for all methods with wide disparities between methods. Figure 2.6 presents a long-term version of Figure 2.5 and depicts long-term CAARs per estimation method and a cumulative average of r_i and r_m for the period t_{-200} to t_600 with t_{-1} as base zero. r_m follows an almost straight line with short-term swings. r_i reveals a clear inflection point around

Table 2.3: Average abnormal returns and their differences

Panel A: Full Sample, N: 1041						
t	IM	MM	GAM	(1) - (2)	(1) - (3)	(2) - (3)
−5	0.0001	−0.0003	−0.0002	0.0003**	0.0003*	−0.0001*
−4	0.0013**	0.0016***	0.0017***	−0.0003*	−0.0004***	−0.0001***
−3	−0.0005	−0.0006	−0.0006	0.0001	0.0001	−0.0001*
−2	0.0007	0.0005	0.0006	0.0002	0.0002	−0.0001**
−1	0.0004	−0.0001	−0.0001	0.0005***	0.0004***	−0.0001
0	0.0063***	0.0059***	0.0060***	0.0004**	0.0003**	0.0000
1	0.0010	0.0007	0.0008	0.0003**	0.0003*	−0.0001***
2	0.0013**	0.0012**	0.0013**	0.0001	0.0000	−0.0001***
3	−0.0001	−0.0003	−0.0002	0.0002	0.0001	−0.0001***
4	0.0001	0.0002	0.0002	−0.0001	−0.0001	0.0000
5	0.0013**	0.0009*	0.0010*	0.0004**	0.0003*	−0.0001***
Panel B: Corrected events only, N: 478						
t	IM	MM	GAM	(1) - (2)	(1) - (3)	(2) - (3)
−5	0.0011	0.0009	0.001	0.0002	0.0001	−0.0001*
−4	0.0026***	0.0031***	0.0034***	−0.0005*	−0.0008**	−0.0003***
−3	0.0001	−0.0003	−0.0001	0.0004	0.0002	−0.0001*
−2	0.0016*	0.0013	0.0015*	0.0003	0.0001	−0.0002**
−1	0.0000	−0.0007	−0.0006	0.0007***	0.0006**	−0.0001
0	0.0029*	0.0026	0.0026	0.0004	0.0003	0.0000
1	0.0017*	0.0012	0.0014	0.0005**	0.0003	−0.0002***
2	0.0012	0.0009	0.0011	0.0003	0.0001	−0.0002***
3	0.0006	0.0003	0.0006	0.0003	0.0.0	−0.0003***
4	−0.0004	0.0000	0.0000	−0.0004	−0.0004*	0.0000
5	0.0012	0.0008	0.0011	0.0004	0.0001	−0.0003***

Notes: The table shows average abnormal returns per event time t with respect to the methodology for the basis of expected return calculation. MM is Market Model, GAM is GARCH-Adjusted Model. IM is Index Model. Panel A uses the full sample while Panel B uses the subset of events where ARCH problems are detected in the estimation period when using OLS. The three right columns show paired difference tests between the indicated models' daily abnormal returns. *$p<0.1$; **$p<0.05$; ***$p<0.01$.



CAARs were calculated on the basis of the full sample. MM is Market Model, IM is Index Model and GAM is GARCH-Adjusted Model. Average company returns and average market returns are added for comparison. Event days are on the x-axis and CAARs are on the y-axis.

Figure 2.6: CAARs for event window -200 to +600

the event date as it accumulates faster than the market pre-event and drastically slower post-event. Accordingly, the Index Model CAAR rose by almost 5% during the 200 days before the announcement. Market Model and GARCH-Adjusted Model CAARs were close to 0 during the same period, with GAM returning slightly greater returns than MM. This disparity was maintained and continued into post-event CAARs. The Index Model (IM) CAAR is always greater than the Market Model and GARCH-Adjusted Model CAARs and GAM CAARs are consistently greater than Market Model CAARs. The MM and GAM are negative roughly 60 days after announcement while the IM takes approximately 75 days to become permanently negative. The steepest drop for all models occurred in the period between these two intersection points (60 and 75 days). At day 600, the CAAR for the MM was at almost -21%, approximately -16% for the GAM and only -6.5% for the IM.

A numerical investigation confirmed the tentative findings from Figure 2.6. Table 2.4 presents three panels, one for each estimation method, where each panel consists of shorter event windows at the top and longer event windows at the bottom. Next to CAARs and their significances, descriptive statistics are also provided. Note that standard deviations and absolute values of minima and maxima tended to increase as event windows were lengthened for all models.

The Index Model depicted in Table 2.4, Panel A contains significant positive CAARs for short-term windows (t_0 to t_1 to t_{-10} to $t_1$0) and windows that included longer pre-event times (t_{-20} to t_{20} to t_{-60} to t_{-3}). Post-event returns were initially non-significant (t_3 to $t_6$0) and then turned significant negative (t_3 to $t_1$30 to t_3 to $t_5$20). Some minima and maxima had large values beyond an absolute value of 1. The largest of these was the minimum of -430% and a maximum of 183% for the longest event window (t_3 to $t_5$20). The CAAR for this window was -7.74%. Such CAARs values are possible because AARs are cumulated rather than compounded.

Just as in the IM, the Market Model lead to significant positive returns for shorter event windows (refer to the first ten rows of the respective panel in Table 2.4). Returns remain significant positive until the 20 day mark, then turn non-significant and become negative around t_{60}; an observation that is consistent with the findings presented in Figure 2.5. Longer event windows exhibit significant negative returns. Again, some large minima and maxima were evident with -639% 230% at t_3 to $t_5$20. The CAAR for the period t_3 to $t_5$20 is -20.09%.

The GAM significance tests and respective signs for short-term windows were largely similar to the MM, with the distinction that CAARs remained significant positive into longer event windows. Longer symmetric windows (t_{-30} to $t_3$0, up to t_{-50} to $t_5$0) were still positive while they were insignificant when using the MM. This finding was not due to a possible positive return in the pre event phase, as might be suggested from Figure 2.6, since the CAAR for t_{-60} to t_{-3} was not significant. GAM results align with MM results in that long-term post-announcement CAARs (t_3 to $t_6$0 until t_3 to $t_5$20) were negative, although the GAM was less negative than the MM, as indicated in Figure 2.4 and Figure 2.6. While the maxima between GAM and MM are the same (as no correction was necessary on that event), the minimum

Table 2.4: Cumulative average abnormal returns, full sample

t	N	CAAR	std	min	median	max
Panel A: Index Model						
0 to 1	1041	0.0073***	0.0462	−0.3057	0.0053	0.3504
0 to 2	1041	0.0086***	0.0499	−0.3596	0.0052	0.3770
0 to 5	1040	0.0100***	0.0593	−0.4505	0.0062	0.3397
0 to 10	1040	0.0108***	0.0703	−0.5427	0.0110	0.2692
-2 to 0	1041	0.0074***	0.0476	−0.2759	0.0049	0.2188
-2 to 2	1041	0.0097***	0.0562	−0.3690	0.0064	0.2625
-3 to 3	1041	0.0092***	0.0605	−0.4748	0.0069	0.2525
-5 to 5	1040	0.0119***	0.0673	−0.5116	0.0059	0.2894
-5 to 10	1040	0.0126***	0.0775	−0.6037	0.0093	0.2915
-10 to 10	1040	0.0115***	0.0829	−0.7195	0.0108	0.3485
-20 to 20	1039	0.0166***	0.1069	−0.4371	0.0177	0.3591
-30 to 30	1039	0.0183***	0.1259	−0.5926	0.0250	0.4869
-50 to 50	1039	0.0272***	0.1619	−0.6802	0.0316	0.7465
-60 to -3	1041	0.0161***	0.1219	−0.4705	0.0121	0.6709
3 to 60	1038	0.0013	0.1207	−0.8645	0.0088	0.5389
3 to 130	1036	−0.0200***	0.2091	−1.3596	−0.0033	0.6140
3 to 260	1024	−0.0310***	0.3273	−3.2388	0.0022	1.3762
3 to 520	934	−0.0774***	0.5590	−4.3003	0.0261	1.8311
Panel B: Market Model						
t	N	CAAR	std	min	median	max
0 to 1	1041	0.0066***	0.0457	−0.2946	0.0042	0.3412
0 to 2	1041	0.0078***	0.0497	−0.3441	0.0041	0.3628
0 to 5	1040	0.0086***	0.0593	−0.4298	0.0037	0.3100
0 to 10	1040	0.0079***	0.0716	−0.5099	0.0067	0.2521
-2 to 0	1041	0.0063***	0.0468	−0.2923	0.0038	0.2122
-2 to 2	1041	0.0082***	0.0557	−0.3538	0.0053	0.2512
-3 to 3	1041	0.0072***	0.0605	−0.4429	0.0041	0.2601
-5 to 5	1040	0.0095***	0.0684	−0.4723	0.0030	0.2687
-5 to 10	1040	0.0089***	0.0803	−0.5524	0.0059	0.2924
-10 to 10	1040	0.0063**	0.0863	−0.6547	0.0058	0.2906
-20 to 20	1039	0.0061*	0.1166	−0.5252	0.0107	0.4157
-30 to 30	1039	0.0040	0.1404	−0.7605	0.0055	0.5905
-50 to 50	1039	0.0029	0.1890	−0.9160	−0.0053	0.8868
-60 to -3	1041	0.0018	0.1333	−0.7148	−0.0019	0.8155
3 to 60	1038	−0.0123***	0.1374	−0.7659	−0.0127	0.5656
3 to 130	1036	−0.0506***	0.2484	−1.3671	−0.0256	0.7237
3 to 260	1024	−0.0925***	0.4402	−4.5482	−0.0588	1.1361
3 to 520	934	−0.2009***	0.8250	−6.3938	−0.1323	2.3209
Panel C: GARCH Adjusted Model						
t	N	CAAR	std	min	median	max
0 to 1	1041	0.0067***	0.0457	−0.2946	0.0036	0.3430
0 to 2	1041	0.0080***	0.0497	−0.3441	0.0044	0.3658
0 to 5	1040	0.0090***	0.0593	−0.4298	0.0040	0.3168
0 to 10	1040	0.0089***	0.0717	−0.5099	0.0064	0.2521
-2 to 0	1041	0.0065***	0.0468	−0.2923	0.0036	0.2122
-2 to 2	1041	0.0085***	0.0558	−0.3538	0.0053	0.2512
-3 to 3	1041	0.0077***	0.0605	−0.4429	0.0046	0.2601
-5 to 5	1040	0.0104***	0.0681	−0.4723	0.0030	0.2724
-5 to 10	1040	0.0102***	0.0801	−0.5524	0.0058	0.3156
-10 to 10	1040	0.0080***	0.0866	−0.6547	0.0071	0.2932
-20 to 20	1039	0.0094***	0.1164	−0.5252	0.0139	0.4277
-30 to 30	1039	0.0092**	0.1404	−0.7605	0.0081	0.5905
-50 to 50	1039	0.0111*	0.1903	−0.6434	−0.0027	0.8868
-60 to -3	1041	0.0062	0.1344	−0.6331	−0.0013	0.8155
3 to 60	1038	−0.0077*	0.1354	−0.7659	−0.0085	0.5656
3 to 130	1036	−0.0410***	0.2429	−1.1718	−0.0250	0.7753
3 to 260	1024	−0.0731***	0.4311	−4.2379	−0.0450	1.2839
3 to 520	934	−0.1595***	0.7936	−4.7244	−0.1004	2.3209

Notes: Descriptive statistics are listed for cumulative abnormal returns of the full sample. The mean column indicates the CAAR and its significance per event window and estimation method of the expected return. *p<0.1; **p<0.05; ***p<0.01.

for GAM was of smaller magnitude compared to MM (-472% vs. -639% on t_3 to t_{520}). Finally, the CAAR for the window t_3 to t_520 was -19.24%.

The differences in CAARs should also be examined on the set of events with ARCH problems in MM modelling only. As such, Table 2.5 lists CAARs per model and CAAR differences for the model pairs of ARCH-affected events. With positive short-term CAARs and negative long-term CAARs, the general tendency for CAARs on the corrected subsample was the same as for the full sample. Short term CAARs were occasionally insignificant for the MM, which might be due to the fact that it is arbitrary which events experience ARCH effects and therefore the construction of the subsample was arbitrary by extension.[10]. It was illustrative to see that ARs from the IM were greater than those from the GAM which in turn exceeded MM abnormal returns, which confirmed the general trend from the full sample. As suspected from Figure 2.4, the pre-event window t_{-60} to t_{-3} was significant positive for the GAM.

The comparison of AARs and CAARs using different expecting return generating mechanisms leads us to three findings: (1) Bidding firm shareholders gain significant abnormal returns on the event date; (2) the short-term gain quickly dissipates and turns into a loss, which deepens in the long run; and (3) ARs on the basis of the Index Model are greater than ARs from the GARCH-Adjusted Model, which in turn, are greater than ARs from the Market Model. The question of statistical significance of these differences is discussed below.

2.4.4 Model Differences

It is possible that the observed differences between AARs and CAARs are within acceptable confidence intervals. This subsection provides analysis of the statistical differences between AARs and CAARs from different models on the basis of the full and the corrected samples.

Differences in AARs for the full and corrected sample are presented in the right-

[10]As opposed to sample selection by by underlying economics

Table 2.5: Cumulative average abnormal returns, corrected events only

t	IM	MM	GAM	(1) - (2)	(1) - (3)	(2) - (3)
0 to 1	0.0047**	0.0038*	0.0040**	0.0009***	0.0006*	−0.0002**
0 to 2	0.0058***	0.0046**	0.0051**	0.0012***	0.0008*	−0.0004***
0 to 5	0.0073***	0.0058**	0.0068***	0.0015**	0.0005	−0.0011***
0 to 10	0.0084***	0.0052	0.0073**	0.0031***	0.0011	−0.0020***
-2 to 0	0.0045**	0.0031	0.0035*	0.0014***	0.0011**	−0.0003**
-2 to 2	0.0075***	0.0052**	0.0059**	0.0022***	0.0015***	−0.0007***
-3 to 3	0.0082***	0.0053**	0.0064**	0.0029***	0.0018***	−0.0011***
-5 to 5	0.0126***	0.0100***	0.0119***	0.0026***	0.0007	−0.0020***
-5 to 10	0.0137***	0.0095**	0.0124***	0.0042***	0.0013	−0.0029***
-10 to 10	0.0109***	0.0045	0.0082**	0.0064***	0.0027*	−0.0037***
-20 to 20	0.0138***	0.0009	0.0082	0.0129***	0.0056**	−0.0073***
-30 to 30	0.0176***	−0.0008	0.0105	0.0185***	0.0072**	−0.0113***
-50 to 50	0.0299***	−0.0027	0.0153	0.0326***	0.0146***	−0.0180***
-60 to -3	0.0220***	0.0017	0.0115*	0.0202***	0.0105***	−0.0098***
3 to 60	0.0030	−0.0135**	−0.0035	0.0165***	0.0064*	−0.010***
3 to 130	−0.0267***	−0.0625***	−0.0416***	0.0358***	0.0150**	−0.0209***
3 to 260	−0.0343**	−0.1035***	−0.0615***	0.0692***	0.0272**	−0.0421***
3 to 520	−0.0837***	−0.2285***	−0.1417***	0.1448***	0.0580**	−0.0868***

The table repeats the mean calculations from Table 2.4 and shows mean differences on basis of the subset of events where ARCH effects are detected in the estimation period when using OLS. MM is Market Model, GAM is GARCH-Adjusted Model. IM is Index Model. *$p<0.1$; **$p<0.05$; ***$p<0.01$.

most three columns in Table 2.3. A positive significant difference in betas (see Figure 2.3 and Figure 2.2) translated into significantly negative AAR differences between the MM and GAM for both the full sample and the corrected subsample. Consistent across both samples, the only days with non significant differences were t_{-1}, t_0 and t_4. This lack of significance can be explained by a small magnitude of market movement on that event day.[11] These differences are consistently visible at the fourth decimal point only. These small but significant differences, however, add up and translate into greater differences for CAARs. Differences of each MM and GAM to the Index Model are erratic, which is due to the fact that differences to IM are driven by the sign and magnitude of r_m.[12]

The differences between the MM and GAM were greater when considering the corrected subsample only (see Panel B in Table 2.3), as the zero differences between the MM and GAM for uncorrected events are removed. As the differences between IM and the other two models were usually not zero (unless $\alpha = 0$ and $\beta = 1$), the differences might be entirely different for the subsample of corrected events. In fact, differences between the IM and MM as well as the IM and GAM were significant less often than for the whole sample.

As suspected from the AAR differences and from Figure 2.5 and Figure 2.6, CAAR differences for the full sample, listed in Table 2.6, amplified the small daily differences such that even for small windows the relationship IM > GAM > MM was statistically significant for the full sample. After two years (t_3 to $t_5 20$), IM was 12.35% greater than the MM and 8.21% greater than the GAM. The MM was 4.14% smaller than the GAM.

Again, the difference between the MM returns and GAM returns were amplified after removing uncorrected events (Table 2.5, rightmost three columns) as the effect of zero differences from uncorrected events was omitted. The difference between the

[11]Differences in ARs depend on beta, amplified by the magnitude of market return, as $AR_m m - AR_g am = (\alpha_{gam} + \beta_{gam} r_m) - (\alpha_{mm} + \beta_{mm} r_m)$. Therefore, assuming that alphas are zero on average, a day's AAR difference will be insignificant when the average r_m is close to zero for that day.

[12]If $\beta_{MM} < 1$ then $AR_{IM} > AR_{MM}$ when $r_m < 0$. $AR_{MM} > AR_{IM}$ when $r_m > 0$. Vice versa if *beta* >1. The same holds for GAM. Since average beta is constant for columns 4 and 5, respectively, in Table 2.3 the changing signs are due to changes in r_m.

Table 2.6: CAAR differences, all events

t	IM - MM	IM - GAM	MM - GAM
0 to 1	0.0007***	0.0006***	−0.0001**
0 to 2	0.0008***	0.0006**	−0.0002***
0 to 5	0.0015***	0.0010**	−0.0005***
0 to 10	0.0028***	0.0019***	−0.0009***
-2 to 0	0.0011***	0.0009***	−0.0002**
-2 to 2	0.0016***	0.0012***	−0.0003***
-3 to 3	0.0019***	0.0014***	−0.0005***
-5 to 5	0.0024***	0.0015**	−0.0009***
-5 to 10	0.0038***	0.0024***	−0.0014***
-10 to 10	0.0052***	0.0035***	−0.0017***
-20 to 20	0.0105***	0.0072***	−0.0033***
-30 to 30	0.0143***	0.0091***	−0.0052***
-50 to 50	0.0243***	0.0161***	−0.0083***
-60 to -3	0.0143***	0.0098***	−0.0045***
3 to 60	0.0136***	0.0090***	−0.0046***
3 to 130	0.0306***	0.0210***	−0.0096***
3 to 260	0.0616***	0.0422***	−0.0194***
3 to 520	0.1235***	0.0821***	−0.0414***

Notes: Each column lists the average difference between the indicated models' cumulative abnormal returns. The asterisks indicate significances for paired difference tests. *, ** and *** indicate significance at 90%, 95% and 99%, respectively. MM is Market Model, GAM is GARCH-Adjusted Model and IM is Index Model. The basis of calculations is the full sample.

MM returns and the GAM returns in the two-year window was 8.68%. Since there were no zero differences for uncorrected events when comparing either the MM or GAM to IM, the only questions remaining were whether the IM and GAM were statistically different, and whether the general pattern that the IM is greater than both the MM and the GAM holds.[13] Results reveal that the general pattern holds as most rows were positive and significant, with the exception of the occasional window for IM − GAM where no significant difference was found.

2.4.5 Prediction Model Differences

Event studies usually examine the mean ARs and CARs, and then attempt to uncover the drivers of CARs using cross-sectional regression. If there are differences in abnormal returns arising from the ARCH correction, these might be visible in various cross-sectional coefficients when relating abnormal returns to some common predictors. This subsection presents analysis of differences in coefficients from such regressions. The question is: Does a GARCH correction impact on the coefficients from regression when compared to the Market Model? OLS regressions were modelled with CARs from the IM, MM and GAM, for both the full sample and corrected sample.

Coefficient difference tests were performed on the basis of their estimates and standard errors. In addition to the deal characteristics presented in Panel A (repeated from Table 2.2), Panel B in Table 2.7 lists cross-sectional variables for sample acquirers after removing missing observations on the cross-sectional variables. Notable values are a maximum Tobin's Q (q) of 22 and a minimum sales growth of -0.48. While far from the TQ mean of 2.42, this variable is known to fluctuate wildly (see for example Danbolt et al. 2017). Given that the dot-com bubble is part of our observation period, the value of 22 is not surprising.

Correlations between variables used in regressions are listed in Table 2.8. Al-

[13]That is unless the MM or GAM parameters were exactly $\alpha = 0$ and $\beta = 1$.

Table 2.7: Descriptives of cross sectional variables

Panel A: Deal characteristics	N	mean	std	min	median	max
ex post takeover count	174	20.5632	33.3774	1	9	295
event date	763			1995-03-13		2014-12-16
deal value	763	773.4619	2625.6167	12.0619	152.0755	41 448.6623
market cap	763	8.6727	17.5530	1.0255	3.3108	175.9216
rel deal value	763	0.0937	0.1640	0.0102	0.0328	1.0458
pct acquired	763	0.8848	0.2334	0.0919	1.0000	1.0000
same industry	763	0.3159	0.4652	0.0000	0.0000	1.0000
Panel B: Acquirer characteristics	**N**	**mean**	**std**	**min**	**median**	**max**
q	763	1.9585	2.4243	0.4384	1.4474	22.3551
asset utilisation	763	1.1018	0.6827	0.1310	0.9358	4.3012
expense ratio	763	0.8532	0.1009	0.4931	0.8682	1.1112
div on assets	763	0.0348	0.0245	0.0000	0.0291	0.1729
investment	763	0.0554	0.0379	0.0020	0.0482	0.2350
tangible	763	0.3216	0.2254	0.0063	0.2737	0.8881
sales growth	763	0.1123	0.2368	−0.4821	0.0726	1.4517
roa	763	0.1296	0.0779	−0.0416	0.1183	0.4771
leverage	763	0.2562	0.1735	0.0000	0.2316	1.0129
mva	763	10.7114	20.2609	1.0592	4.3340	195.9127
mtb similarity	763	0.2524	0.1442	0.0000	0.2810	0.5335
size similarity	763	0.0415	0.1533	0.0000	0.0048	0.8927
Panel C: Industry/macro variables	**N**	**mean**	**std**	**min**	**median**	**max**
intensity	763	0.2814	0.1310	0.0000	0.2548	0.6567
herfindahl	763	0.0578	0.0837	0.0092	0.0262	0.5576
gdp growth	763	0.0242	0.0172	−0.0593	0.0259	0.0479

Notes: The table shows descriptive statistics for the variables used in cross sectional variables. Variable definitions are in Table A.1 in Appendix A. market cap and mva are presented in billion GBP here.

though there were some significant values, their magnitude was usually small. The highest correlation was observed between the investment rate (*investment*) and tangibility (*tangible*) with 0.63, which was exceptionally high in our sample. Other high correlations were seen between expense ratio and asset utilisation ratio (0.51) and market value of assets and the Herfindahl Index (0.46). The strongest negative correlation was -0.43 between profitability (*roa*) and expense ratio.

Cross-sectional results are listed in Table 2.9 and Table 2.10 which correspond to the difference test presented in Table 2.11, Panel A and Panel B respectively. Each cross-sectional table presents models for the IM, MM and GAM for the full sample on the left and the same three models for the corrected sample on the right. The analysis of significant coefficients mainly focuses on the full sample, as the occurrence of ARCH effects might be too arbitrary to allow an overall statement about general CAR creation.

All long-term models (Table 2.9) demonstrate that higher TQ firms, larger firms (with the exception of IM in the corrected sample), firms acquiring in times of high takeover intensity and coming from more concentrated industries accrued significantly lower CARs (full and corrected sample). There was some limited evidence of a negative impact of sales growth, the investment rate and economic growth on long-term CAR creation. Profitability was significant positive for IM and MM in both samples. Asset utilisation and tangibility had a positive effect on CARs in all corrected sample models. The remaining variables were significant only occasionally or not at all. The constant was significant positive in all models.

In the short-term CAR models (Table 2.10), all models (full and corrected) returned significant positive effects of return on assets (*roa*) and leverage, and negative effects from Tobin's Q, sales growth and firm size (*ln mva*). There was some evidence for a positive effect of industry concentration (*herfindahl*) on CARs in the full sample. The expense ratio was significant positive while there was some evidence for a negative impact of the percentage of equity acquired (*pct acquired*) in the MM and the GAM in the full sample, but not for the IM and not in the corrected subsample.

Table 2.8: Correlation Coefficients of cross sectional variables

	(1) rel deal value	(2)	(3)	(4)	(5)	(6)	(7)	(8)	
(2) pct acquired	0.08**								
(3) same industry	0.09**	−0.12 ***							
(4) q	−0.04	0.02	0.00						
(5) asset utilisation	−0.10 ***	0.16***	−0.09 **	0.23***					
(6) expense ratio	−0.10 ***	0.09**	−0.21 ***	−0.10 ***	0.51***				
(7) div on assets	−0.02	0.06*	−0.04	0.20***	0.14***	−0.23 ***			
(8) investment	−0.04	−0.13 ***	0.05	0.08**	0.00	−0.16 ***	0.00		
(9) tangible	0.03	−0.08 **	0.07*	−0.16 ***	−0.24 ***	−0.18 ***	−0.06	0.63***	
(10) sales growth	−0.02	−0.07 **	0.06*	0.11***	0.11***	−0.05	−0.15 ***	0.07**	
(11) roa	−0.01	0.04	0.03	0.44***	0.20***	−0.43 ***	0.47***	0.16***	
(12) leverage	0.13***	−0.10 ***	0.12***	0.04	−0.26 ***	−0.31 ***	0.12***	0.03	
(13) mva	0.00	−0.20 ***	−0.01	0.00	−0.15 ***	−0.12 ***	0.16***	0.09**	
(13) mtb similarity	−0.10 ***	0.00	0.09***	−0.23 ***	−0.06	0.08**	−0.28 ***	0.05	
(15) size similarity	0.00	−0.07 **	0.13***	0.01	−0.05	−0.12 ***	−0.11 ***	0.13***	
(16) intensity	−0.01	−0.01	0.01	0.12***	0.05	−0.02	−0.08 **	0.07*	
(17) herfindahl	0.06	−0.09 **	0.04	0.03	−0.07 *	−0.09 **	0.11***	0.17***	
(18) gdp growth	0.07**	−0.04	0.01	0.09**	0.06	0.07**	0.04	0.08**	
	(9) tangible	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
(10) sales growth	−0.06 *								
(11) roa	−0.12 ***	0.12***							
(12) leverage	0.19***	0.06*	0.09**						
(13) mva	0.12***	−0.02	0.01	0.05					
(14) mtb similarity	0.11***	−0.02	−0.22 ***	−0.21 ***	−0.14 ***				
(15) size similarity	−0.02	0.21***	−0.08 **	−0.07 *	−0.10 ***	0.14***			
(16) intensity	0.01	0.13***	0.09**	0.06*	−0.11 ***	0.20***	0.05		
(17) herfindahl	0.14***	0.03	−0.06	−0.06	0.46***	−0.20 ***	0.27***	−0.21 ***	
(18) gdp growth	0.09**	0.04	0.03	0.09**	−0.04	−0.12 ***	−0.17 ***	0.14***	−0.06 *

Notes: Displayed are Spearman correlations between the indicated variable pairs. Variable definitions are in Table A.1. *p<0.1; **p<0.05; ***p<0.01.

Table 2.9: Cross-sectional results, long-term

	Dependent variable: CAR t_3 to t_{520}					
	Panel A: All events			Panel B: Corrected events only		
	IM	MM	GAM	IM	MM	GAM
	(1)	(2)	(3)	(4)	(5)	(6)
rel deal value	−0.175	−0.005	−0.059	−0.340*	−0.271	−0.389
	(0.150)	(0.227)	(0.228)	(0.198)	(0.287)	(0.318)
pct acquired	−0.109	−0.215	−0.199	−0.138	−0.694**	−0.557**
	(0.113)	(0.152)	(0.146)	(0.208)	(0.284)	(0.259)
same industry	0.020	−0.007	−0.009	0.019	0.166	0.176
	(0.043)	(0.063)	(0.066)	(0.075)	(0.115)	(0.124)
mtb similarity	−0.285	−0.594*	−0.410	−0.940**	−1.180**	−0.733
	(0.206)	(0.303)	(0.313)	(0.406)	(0.593)	(0.589)
size similarity	0.158	−0.358	−0.222	−0.696	−1.513**	−1.002*
	(0.235)	(0.319)	(0.251)	(0.579)	(0.725)	(0.570)
q	−0.043**	−0.132***	−0.102***	−0.038*	−0.111***	−0.072**
	(0.018)	(0.028)	(0.027)	(0.023)	(0.036)	(0.034)
roa	1.423***	1.805***	1.064	1.811**	2.426**	0.854
	(0.438)	(0.608)	(0.731)	(0.823)	(1.105)	(1.259)
sales growth	−0.311*	−0.470**	−0.478***	−0.260	−0.425*	−0.437**
	(0.170)	(0.189)	(0.171)	(0.192)	(0.229)	(0.197)
leverage	0.010	0.002	0.001	0.369	0.367	0.206
	(0.189)	(0.235)	(0.244)	(0.290)	(0.416)	(0.435)
ln mva	−0.047**	−0.089***	−0.087***	−0.057	−0.120**	−0.133***
	(0.023)	(0.032)	(0.032)	(0.038)	(0.050)	(0.051)
asset utilisation	0.085	0.036	0.048	0.130*	0.192**	0.207**
	(0.052)	(0.062)	(0.065)	(0.076)	(0.093)	(0.100)
expense ratio	−0.383	−0.100	−0.103	−0.467	−1.018	−1.204
	(0.462)	(0.533)	(0.553)	(0.831)	(1.018)	(1.112)
div on assets	0.855	2.774	3.277*	0.944	0.797	2.458
	(0.963)	(1.710)	(1.679)	(1.574)	(2.478)	(2.412)
investment	−2.497***	−0.145	0.157	−3.102**	−3.975**	−3.923**
	(0.905)	(1.161)	(1.243)	(1.361)	(1.824)	(1.981)
tangible	0.293*	0.405*	0.296	0.660***	1.391***	1.106***
	(0.159)	(0.230)	(0.235)	(0.245)	(0.361)	(0.361)
intensity	−2.088***	−1.935***	−1.844***	−2.689***	−2.762***	−2.809***
	(0.388)	(0.586)	(0.556)	(0.580)	(0.828)	(0.784)
herfindahl	−1.230**	−2.075***	−1.808**	−3.373***	−4.775***	−4.102***
	(0.479)	(0.743)	(0.730)	(1.010)	(1.451)	(1.463)
gdp growth	−6.870**	−6.262*	−6.481*	−7.677*	−8.916	−9.817*
	(2.747)	(3.546)	(3.783)	(4.056)	(5.629)	(5.832)
Constant	1.447**	1.981**	1.840**	2.587**	4.241***	4.447***
	(0.579)	(0.781)	(0.765)	(1.079)	(1.411)	(1.474)
N	695	695	695	313	313	313
R^2	0.321	0.319	0.258	0.419	0.473	0.390
Adjusted R^2	0.274	0.272	0.207	0.321	0.384	0.287
Residual Std. Error	0.513	0.730	0.728	0.571	0.804	0.804
df (SE)	649	649	649	267	267	267
F Statistic	6.811***	6.751***	5.020***	4.281***	5.330***	3.787***
df (F)	45; 649	45; 649	45; 649	45; 267	45; 267	45; 267

Notes: This table presents multiple regression models with CARs as the dependent variable. Variable descriptions are listed in Table A.1 in Appendix A. Panel A is based on all events while Panel B only uses CARs from models that displayed ARCH problems in an OLS-based event method. All models include year and industry dummies (excluded from the output). Heteroscedasticity-robust standard errors are provided in parentheses. *p<0.1; **p<0.05; ***p<0.01

Other variables were occasionally significant without a clear pattern. Again, the constant was always significant positive.

In the full sample, all models also returned negative effects from tangibility (*tangible*) and economic growth (*gdp growth*). In the corrected subsample, all models revealed negative effects of relative deal size (*rel deal value*), size similarity between bidders, and industry concentration (*herfindahl*). The MM and GAM results for the full sample showed a positive effect of higher leverage on short-term CARs and a negative effect from the percentage acquired (*pct acquired*). The Index Model alone produced a positive effect of same industry for the full sample.

Table 2.11 lists the coefficient differences from regression models using long-term CARs (Panel A) and short-term CARs (Panel B) as the dependent variables. As shown by the lack of significance, there was no significant difference between the MM and GAM coefficients with either long- or short-term CARs neither for the full nor the corrected subsample. The Index Model lead to a significantly higher coefficient for TQ (q) in models with long-term CARs in both the full and corrected sample with the exception of difference to GAM in the corrected subsample. The only other, though weakly, significant coefficient difference is for investment between IM and GAM in the full sample. There were no coefficient differences for short-term CAR models. CAARs were significantly different (see Tables 2.5 and 2.6), but apparent differences in the short-term were too small to detect significant differences in coefficients.

Comparing signs and significance levels of the models supports this finding.[14] Importantly, for the comparison columns between the MM and GAM, whenever a coefficient was significant for either method, that coefficient always had the same sign in the other method even though the level of significance occasionally differed. Sometimes, one of the methods returned significant results where the other did not. In case of the short term models MM and GAM significances and signs were perfectly congruent for the full sample and congruent with the exception of *size similarity* for

[14]Refer to Table A.2 in Appendix A as an aid.

Table 2.10: Cross-sectional results, short-term

	Dependent variable: CAR t_0 to t_{10}					
	All events			Corrected events only		
	IM	MM	GAM	IM	MM	GAM
	(1)	(2)	(3)	(4)	(5)	(6)
rel deal value	0.010	0.014	0.013	−0.016	−0.019	−0.022
	(0.021)	(0.022)	(0.022)	(0.026)	(0.028)	(0.028)
pct acquired	−0.017	−0.022*	−0.022*	−0.010	−0.021	−0.020
	(0.011)	(0.012)	(0.012)	(0.016)	(0.017)	(0.017)
same industry	0.008	0.009	0.009	−0.008	−0.003	−0.003
	(0.005)	(0.006)	(0.006)	(0.010)	(0.011)	(0.011)
mtb similarity	0.018	0.014	0.020	−0.018	−0.027	−0.013
	(0.033)	(0.032)	(0.032)	(0.045)	(0.048)	(0.047)
size similarity	0.017	−0.002	0.001	−0.048	−0.065**	−0.052
	(0.022)	(0.023)	(0.022)	(0.031)	(0.032)	(0.033)
q	−0.005**	−0.006***	−0.005***	−0.006***	−0.007***	−0.006***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
roa	0.156**	0.170***	0.158***	0.251***	0.275***	0.251***
	(0.063)	(0.063)	(0.061)	(0.085)	(0.090)	(0.088)
sales growth	−0.036***	−0.040***	−0.040***	−0.043***	−0.044***	−0.043***
	(0.014)	(0.014)	(0.014)	(0.015)	(0.015)	(0.016)
leverage	0.054***	0.059***	0.061***	0.065**	0.068**	0.071**
	(0.020)	(0.020)	(0.020)	(0.030)	(0.032)	(0.032)
ln mva	−0.016***	−0.017***	−0.017***	−0.018***	−0.020***	−0.021***
	(0.003)	(0.003)	(0.003)	(0.005)	(0.005)	(0.005)
asset utilisation	−0.0004	−0.001	−0.001	0.0002	−0.001	0.001
	(0.005)	(0.005)	(0.005)	(0.008)	(0.008)	(0.008)
expense ratio	0.065	0.094**	0.095**	0.083	0.113	0.110
	(0.041)	(0.043)	(0.042)	(0.080)	(0.089)	(0.088)
div on assets	0.008	0.072	0.087	−0.297	−0.251	−0.203
	(0.139)	(0.142)	(0.141)	(0.187)	(0.190)	(0.193)
investment	−0.200*	−0.167	−0.165	−0.033	−0.086	−0.107
	(0.118)	(0.118)	(0.118)	(0.147)	(0.157)	(0.158)
tangible	0.007	0.016	0.016	0.010	0.033	0.031
	(0.017)	(0.017)	(0.017)	(0.028)	(0.031)	(0.030)
intensity	−0.050	−0.047	−0.048	−0.061	−0.057	−0.064
	(0.046)	(0.047)	(0.047)	(0.058)	(0.060)	(0.060)
herfindahl	0.144**	0.140*	0.148*	−0.113	−0.134	−0.120
	(0.073)	(0.077)	(0.076)	(0.089)	(0.096)	(0.097)
gdp growth	−0.201	−0.223	−0.214	0.125	0.077	0.106
	(0.299)	(0.299)	(0.298)	(0.424)	(0.427)	(0.440)
Constant	0.190***	0.184**	0.181**	0.262**	0.266**	0.269**
	(0.070)	(0.072)	(0.071)	(0.122)	(0.132)	(0.131)
N	763	763	763	334	334	334
R^2	0.147	0.160	0.154	0.272	0.296	0.286
Adjusted R^2	0.092	0.107	0.099	0.156	0.183	0.171
Residual Std. Error	0.069	0.071	0.071	0.064	0.067	0.068
df (SE)	716	716	716	287	287	287
F Statistic	2.682***	2.975***	2.825***	2.336***	2.618***	2.495***
df (F)	46; 716	46; 716	46; 716	46; 287	46; 287	46; 287

Notes: This table presents multiple regression models with CARs as the dependent variable. Variable descriptions are listed in Table A.1 in Appendix A. Panel A is based on all events while Panel B only uses CARs from models that displayed ARCH problems in an OLS-based event method. All models include year and industry dummies (excluded from the output). Heteroscedasticity-robust standard errors are provided in parentheses. *p<0.1; **p<0.05; ***p<0.01

Table 2.11: Coefficient difference test

Panel A: Long term models (CAR t_3 to t_{520})	All events			Corrected events only		
	IM - MM	IM - GAM	MM - GAM	IM - MM	IM - GAM	MM - GAM
(Intercept)	−0.5493	−0.4103	0.1285	−0.9309	−1.0183	−0.1011
rel deal value	−0.6241	−0.4244	0.1675	−0.1980	0.1298	0.2747
pct acquired	0.5592	0.4869	−0.0745	1.5787	1.2596	−0.3563
same industry	0.3541	0.3761	0.0267	−1.0701	−1.0814	−0.0577
mtb similarity	0.8419	0.3337	−0.4203	0.3334	−0.2896	−0.5347
size similarity	1.3003	1.1028	−0.3353	0.8803	0.3764	−0.5541
q	2.6507***	1.7832*	−0.7774	1.6868*	0.8223	−0.7849
roa	−0.5091	0.4216	0.7794	−0.4462	0.6365	0.9386
sales growth	0.6237	0.6931	0.0325	0.5532	0.6460	0.0413
leverage	0.0270	0.0287	0.0021	0.003	0.3129	0.2693
ln mva	1.0495	0.9955	−0.0480	1.0065	1.2024	0.1807
asset utilisation	0.5981	0.4423	−0.1268	−0.5227	−0.6144	−0.1062
expense ratio	−0.4008	−0.3884	0.0037	0.4190	0.5310	0.1237
div on assets	−0.9781	−1.2520	−0.2100	0.0503	−0.5257	−0.4805
investment	−1.5974	−1.7260*	−0.1775	0.3834	0.3415	−0.0191
tangible	−0.4023	−0.0111	0.3328	−1.6760*	−1.0204	0.5590
intensity	−0.2171	−0.3588	−0.1123	0.0719	0.1228	0.0413
herfindahl	0.9564	0.6624	−0.2564	0.7933	0.4102	−0.3266
gdp growth	−0.1358	−0.0833	0.0424	0.1786	0.3012	0.1112
Panel B: Short term models (CAR t_0 to t_{10})	All events			Corrected events only		
	IM - MM	IM - GAM	MM - GAM	IM - MM	IM - GAM	MM - GAM
(Intercept)	0.0635	0.0924	0.0284	−0.0185	−0.0362	−0.0170
rel deal value	−0.1492	−0.1009	0.0473	0.0653	0.1455	0.0772
pct acquired	0.2976	0.3123	0.0146	0.4739	0.4212	−0.0532
same industry	−0.1564	−0.1389	0.0166	−0.3800	−0.3398	0.0366
mtb similarity	0.0786	−0.0463	−0.1256	0.1293	−0.0794	−0.2027
size similarity	0.5897	0.5103	−0.0872	0.3962	0.0954	−0.2877
q	0.4750	0.2403	−0.2400	0.2947	0.0186	−0.2737
roa	−0.1620	−0.0303	0.1342	−0.1935	0.0000	0.1912
sales growth	0.2409	0.1890	−0.0494	0.0798	0.0140	−0.0630
leverage	−0.1653	−0.2472	−0.0809	−0.0707	−0.1350	−0.0627
ln mva	0.2505	0.3058	0.0544	0.2492	0.3398	0.0890
asset utilisation	0.1393	0.0755	−0.0617	0.0617	−0.0321	−0.0904
expense ratio	−0.4913	−0.5120	−0.0186	−0.2544	−0.2231	0.0307
div on assets	−0.3242	−0.3979	−0.0715	−0.1704	−0.3483	−0.1779
investment	−0.1976	−0.2071	−0.0090	0.2465	0.3442	0.0950
tangible	−0.3932	−0.3735	0.0206	−0.5593	−0.5260	0.0375
intensity	−0.0406	−0.0259	0.0146	−0.0523	0.0330	0.0837
herfindahl	0.0383	−0.0305	−0.0675	0.1594	0.0539	−0.1009
gdp growth	0.0534	0.0321	−0.0213	0.0801	0.0305	−0.0483

Notes: This table lists the z-scores of differences between coefficients from the indicated models. Variable definitions are in Table A.1 in Appendix A. When testing for statistical difference, a normal distribution is assumed. *p<0.1; **p<0.05; ***p<0.01. Panel A is based on models using event-wise CARs from t_3 to t_520. Panel B uses models with event-wise CARs from t_0 to t_10.

the corrected subsample. Similarly, when comparing to the Index Model, signs were pointing in the same direction when a coefficient was significant. Again, differences in significance levels were more pronounced for the long-term models than for the short-term models. GARCH adjustments had no significant effect on coefficients and, therefore, previous studies of drivers of bidding firm results remain intact in light of our results.

2.4.6 Robustness to outliers

In this subsection key tests from this chapter are repeated on basis of a winsorised sample to ensure that results are not driven by outliers. For this purpose, the full sample of CARs was winsorised at 0.5%, both at the upper and lower end of the range. The tests repeated here are the test of CAARs (Table 2.12) and the test of CAAR differences (Table 2.13).

As expected all minima and maxima have decreased in absolute value when comparing to Table 2.4. Since value ranking is not affected by winsorisation, the medians are unchanged. Winsorisation removes variation data so that all standard deviations have decreased. As variation is greater over longer time periods, the two year windows were affected more strongly by winsorisation than shorter windows. CAARs over two years were -7.62% with winsorisation compared to -7.74% without winsorisation for the IM, -19.76% vs. -20.09% for the MM and -15.65% vs. -15.95% for the GAM. The previous finding of positive CAARs in short-term windows and negative CAARs in long term windows is robust and has not been driven by outliers.

CAAR differences, in Table 2.13, were slightly smaller when comparing to the same test without winsorisation (Table 2.6), but nonetheless significant. For all windows CAARs from the Index Model were greater than those from the Market Model and the GARCH-Adjusted Model. The GARCH-Adjusted Model, in turn, found greater CAARs than the Market Model. Accordingly, previous findings are robust to the effects of outliers. After two years GAM was 4.11% greater than MM

Table 2.12: Cumulative average abnormal returns, full sample, winsorised

t	N	CAAR	std	min	median	max
Panel A: Index Model						
0 to 1	1041	0.0073***	0.0418	−0.1611	0.0053	0.1491
0 to 2	1041	0.0089***	0.0452	−0.1556	0.0052	0.1658
0 to 5	1040	0.0103***	0.0553	−0.1915	0.0062	0.1985
0 to 10	1040	0.0114***	0.0659	−0.2227	0.0110	0.2087
-2 to 0	1041	0.0074***	0.0463	−0.1852	0.0049	0.1645
-2 to 2	1041	0.0101***	0.0526	−0.1861	0.0064	0.1819
-3 to 3	1041	0.0096***	0.0560	−0.1982	0.0069	0.1988
-5 to 5	1040	0.0125***	0.0628	−0.1764	0.0059	0.2270
-5 to 10	1040	0.0134***	0.0720	−0.2520	0.0093	0.2319
-10 to 10	1040	0.0123***	0.0759	−0.2865	0.0108	0.2330
-20 to 20	1039	0.0166***	0.1059	−0.4026	0.0177	0.3141
-30 to 30	1039	0.0187***	0.1231	−0.3749	0.0250	0.3874
-50 to 50	1039	0.0271***	0.1585	−0.4853	0.0316	0.5827
-60 to -3	1041	0.0158***	0.1182	−0.3206	0.0121	0.4197
3 to 60	1038	0.0020	0.1157	−0.3804	0.0088	0.3442
3 to 130	1036	−0.0188***	0.2009	−0.8210	−0.0033	0.5004
3 to 260	1024	−0.0301***	0.3053	−1.3276	0.0022	0.6426
3 to 520	934	−0.0762***	0.5371	−2.9115	0.0261	1.0248
Panel B: Market Model						
t	N	CAAR	std	min	median	max
0 to 1	1041	0.0067***	0.0416	−0.1650	0.0042	0.1568
0 to 2	1041	0.0080***	0.0453	−0.1656	0.0041	0.1606
0 to 5	1040	0.0089***	0.0560	−0.2021	0.0037	0.1951
0 to 10	1040	0.0085***	0.0677	−0.2368	0.0067	0.2037
-2 to 0	1041	0.0064***	0.0453	−0.1808	0.0038	0.1607
-2 to 2	1041	0.0085***	0.0525	−0.2010	0.0053	0.1812
-3 to 3	1041	0.0077***	0.0561	−0.2017	0.0041	0.1823
-5 to 5	1040	0.0100***	0.0646	−0.1914	0.0030	0.2191
-5 to 10	1040	0.0095***	0.0763	−0.2987	0.0059	0.2380
-10 to 10	1040	0.0072***	0.0808	−0.2987	0.0058	0.2404
-20 to 20	1039	0.0061*	0.1137	−0.3900	0.0107	0.3345
-30 to 30	1039	0.0043	0.1367	−0.4516	0.0055	0.3937
-50 to 50	1039	0.0028	0.1832	−0.5488	−0.0053	0.5077
-60 to -3	1041	0.0018	0.1290	−0.3721	−0.0019	0.4270
3 to 60	1038	−0.0116***	0.1333	−0.4441	−0.0127	0.4620
3 to 130	1036	−0.0506***	0.2449	−1.1331	−0.0256	0.4951
3 to 260	1024	−0.0886***	0.4119	−1.9636	−0.0588	1.0007
3 to 520	934	−0.1976***	0.7991	−4.5425	−0.1323	1.9061
Panel C: GARCH Adjusted Model						
t	N	CAAR	std	min	median	max
0 to 1	1041	0.0068***	0.0416	−0.1600	0.0036	0.1568
0 to 2	1041	0.0082***	0.0453	−0.1619	0.0044	0.1617
0 to 5	1040	0.0094***	0.0559	−0.2021	0.0040	0.1963
0 to 10	1040	0.0094***	0.0678	−0.2367	0.0064	0.2037
-2 to 0	1041	0.0066***	0.0454	−0.1808	0.0036	0.1607
-2 to 2	1041	0.0088***	0.0527	−0.1991	0.0053	0.1812
-3 to 3	1041	0.0082***	0.0564	−0.2026	0.0046	0.1915
-5 to 5	1040	0.0109***	0.0644	−0.1896	0.0030	0.2206
-5 to 10	1040	0.0108***	0.0761	−0.2862	0.0058	0.2415
-10 to 10	1040	0.0088***	0.0815	−0.3046	0.0071	0.2550
-20 to 20	1039	0.0096***	0.1140	−0.3642	0.0139	0.3719
-30 to 30	1039	0.0094**	0.1372	−0.4034	0.0081	0.4035
-50 to 50	1039	0.0112*	0.1876	−0.5055	−0.0027	0.6238
-60 to -3	1041	0.0061	0.1306	−0.3458	−0.0013	0.4378
3 to 60	1038	−0.0071*	0.1318	−0.4063	−0.0085	0.4748
3 to 130	1036	−0.0410***	0.2391	−1.0414	−0.0250	0.5838
3 to 260	1024	−0.0693***	0.4065	−1.5839	−0.0450	1.1031
3 to 520	934	−0.1565***	0.7745	−3.6193	−0.1004	1.9985

Notes: The table repeats the descriptive statistics from Table 2.4 on basis of winsorised cumulative average abnormal returns at 0.5% on each side on the full sample. The mean column indicates the CAAR and its significance per event window and estimation method of the expected return. *p<0.1; **p<0.05; ***p<0.01.

Table 2.13: CAAR differences, all events, winsorised

t	IM - MM	IM - GAM	MM - GAM
0 to 1	0.0007***	0.0005**	−0.0001**
0 to 2	0.0009***	0.0007**	−0.0002***
0 to 5	0.0015***	0.0010**	−0.0005***
0 to 10	0.0028***	0.0020***	−0.0009***
-2 to 0	0.0010***	0.0009***	−0.0002**
-2 to 2	0.0016***	0.0013***	−0.0003***
-3 to 3	0.0020***	0.0015***	−0.0005***
-5 to 5	0.0024***	0.0016***	−0.0009***
-5 to 10	0.0039***	0.0025***	−0.0013***
-10 to 10	0.0051***	0.0035***	−0.0016***
-20 to 20	0.0105***	0.0070***	−0.0035***
-30 to 30	0.0144***	0.0093***	−0.0051***
-50 to 50	0.0242***	0.0159***	−0.0083***
-60 to -3	0.0140***	0.0097***	−0.0043***
3 to 60	0.0136***	0.0091***	−0.0045***
3 to 130	0.0318***	0.0223***	−0.0096***
3 to 260	0.0586***	0.0393***	−0.0193***
3 to 520	0.1214***	0.0804***	−0.0411***

Notes: Each column lists the average difference between the indicated models' cumulative abnormal returns from the winsorised, full sample with a degree of 0.5% on each side. The asterisks indicate significances for paired difference tests. *, ** and *** indicate significance at 90%, 95% and 99%, respectively. MM is Market Model, GAM is GARCH-Adjusted Model and IM is Index Model. The basis of calculations is the full sample.

(4.14% without winsorisation), and IM is 8.04% greater than GAM (8.21% without winsorisation).

2.4.7 Discussion

Negative long-term CAARs were expected and are consistent with previous research. Two-year CAARs in the present study were not as negative as in Dargenidou, Gregory & Hua (2016), that is, -11.26% to -14.33% over two years, and Franks & Harris (1989), 12.60% over two years when using a Market Model. A markedly less negative result was reported in Conn et al. (2005) with a buy and hold abnormal return of -9.02% over three years using compounded ARs from the Market Model.[15] More consistent with our results are Aw & Chatterjee (2004) with -24.4% over two years using the MM. Much more negative findings using the MM were reported in

[15] Buy and hold abnormal returns use the cumulative product, i.e., compounding, instead of the cumulative sum to aggregate abnormal returns over a period.

Conn & Connell (1990) with -22.6% CAAR 12 months after announcement. While we observed CAARs becoming negative relatively quickly after announcement — around 75 trading days, i.e., three months for the IM and approximately 11 days for the MM and GAM — Franks & Harris (1989) observed positive CAARs for IM and insignificant CAARs for the MM after half a year. Sudarsanam & Mahate (2003) reported non-significant CAARs over a similar period (t_2 to $t_4$0).

The negative long-term returns are a clear indication of wide-spread agency costs in UK bidding firms. Most acquisitions, to paraphrase Buffett (1981), serve to expand the empire while leaving the citizens poorer. However, this does not necessarily mean that shareholders should forbid M&A. In our sample, 37% of events generated positive abnormal returns over a two-year period.[16]

In contrast to long-term CARs, short-term CARs are about signalling as they depict the expectations of long-term merger success. Our results confirm some UK-based literature which finds significant positive short-term CARs for bidders (Conn et al. 2005, Danbolt et al. 2015, Giannopoulos et al. 2017). Exceptions are Franks & Harris (1989), Limmack (1991) and Higson & Elliott (1998) who have observed non-significant short-term CAARs. Sudarsanam & Mahate (2003) and Raj & Forsyth (2003) reported significant negative short-term CARs in the UK. Note that US studies are usually in line with these latter findings of zero or negative short-term ARs (Dodd 1980, Morck et al. 1990, Schwert 1996, Walker 2000, Andrade et al. 2001, Capron & Pistre 2002).

The combination of positive short-term CAARs and negative long-term CAARs appears consistent throughout many UK-based studies. It is somewhat counter-intuitive that the market's positive assessment upon announcement consistently becomes negative in the long-term. Possible explanations for this change of assessment might be: (1) that markets are not rational, i.e., shareholders are unrealistically optimistic about future merger success; (2) that post-merger problems simply cannot be foreseen or estimated upon announcement and thus are unexpected when such

[16]The figure is based on CARs from the GARCH-Adjusted Model over the period t_3 to $t_5$20 for the full sample.

information becomes public knowledge; or (3) investment banks bolster bidding firm share prices.[17]

The analysis of AAR and CAAR differences revealed that the Market Model leads to significantly lower abnormal returns than its GARCH-corrected counterpart and thus overstates the negative long-term effect of a takeover. GARCH adjustment seems to move CAARs for events needing ARCH correction closer to the CAARs for the sample of takeovers which did not exhibit ARCH effects (see Figure 2.4). This finding, in turn, confirms that GAM betas are consistently lower than their Market Model counterparts, which is also evident in the positive t-tests for mean difference between the MM and GARCH-Adjusted Model betas (see Figures 2.2 and 2.3).[18]

The Index Model, on the other hand, had the opposite problem as it leads to significantly higher returns than the more sophisticated alternatives. The results provide strong support for the necessity of GARCH correction in event study methodology. The difference between GARCH betas and OLS betas is consistent with previous literature (Armitage & Brzeszczynski 2011). In our case, betas might be lower because a portion of the variation collected in the MM beta was due to autoregressive volatility. Note, however, that this finding is not a mathematical implication of GARCH. Corrected events exhibit a more volatile graph progression in Figure 2.4 but neither the graph nor any table make entirely clear that this is due to r_i and not r_m (both are financial return series). This difference, however, is unimportant. ARCH effects might be due to r_m so that the subtrahend in the AR formula (Equation 2.1) causes the more volatile progression of the CAAR lines for corrected events (while ARCH effects were only measured during the estimation period, they might have persisted into the measurement period). Important is that correct for ARCH and that beta was specified properly so that the benchmark and AR, in turn, were

[17]This is common practice in an Initial Public Offering (IPO), for example. It is unlikely though as this practice is too expensive with larger bidders. On the other hand, all events receive equal weights in the CAAR calculation, so that this point may warrant further investigation.

[18]$CAR_{GAM} > CAR_{MM}$ implies that $r_i - (\alpha_{GAM} + \beta_{GAM} r_m) > r_i - (\alpha_{MM} + \beta_{MM} r_m)$. As α can be assumed to be zero on average, $r_i - \beta_{GAM} r_m > r_i - \beta_{MM} r_m$ which is the same as $\beta_{GAM} < \beta_{MM}$ after dropping r_i from both sides.

correct. When ARCH effects were present, a standard MM seemed to overestimate beta in our sample.[19]

Studies of statistical difference in benchmarks are uncommon in the literature on M&A in the UK. As the GAM is our addition to M&A event study literature, no comparison exists. In addition, the use of both the IM and MM in event studies is strangely rare in this strand of literature which may reflect the importance of the risk adjustment. In Franks & Harris (1989), the IM was almost 20% higher than Market Model over two years following takeover for a UK sample. The CAPM in their study is notably similar to the Index Model.

Results for both the MM and GAM did not differ much from results of other studies using a range of related benchmarks (Franks & Harris 1989, Aw & Chatterjee 2004, Conn et al. 2005, Danbolt et al. 2015, Dargenidou et al. 2016, Giannopoulos et al. 2017). Across the range of relevant literature, the simplistic IM seemed to underestimate the severity of abnormal losses. The prevailing hypothesis that acquisitions serve bidding firm management and not shareholders and therefore introduce agency costs remains intact when correcting for ARCH effects. We suspect, however, that the severity of these agency costs has been overestimated in previous studies.

Overall our results confirm previous findings of long-term underperformance of bidding firm shares. However, evidence of short-term CARs for UK bidders in the literature is mixed and our results confirm those that have reported gains (for example Franks & Harris 1989). The statistically significant difference of 4.14% between MM and GAM over two years translates to an economically significant disparity in value creation of £373.53mn for the average bidder in our sample. Comparing MM to IM this disparity increases to £1.11bn.

The evidence in this chapter contains implications for academics, practitioners and regulators. For academics the main implications lie in the effects of ARCH when

[19] Which we did in the vast majority of cases. Only 3.96% of events were excluded due to the remaining ARCH problems. We did not find it necessary to apply multivariate GARCH models, which would allow for ARCH effects in r_m.

applying event study methodology. When ARCH effects are present in the estimation period of an event, OLS seems to consistently overestimate systemic risk of bidders. The event study arithmetic then implies higher expected returns which lead to significantly lower abnormal returns. Accordingly, it is reasonable to assume that previous research has understated abnormal returns for bidding firm shareholders. Coefficients in previous cross-sectional studies are not affected by these differences so that they remain valid. For shareholders, the traditional finding of long-term value destruction of M&A must be upward corrected. Still, on average, shareholder value is destroyed, implying UK takeovers are serving management more than its shareholders and are therefore incurring agency costs. Executives and directors are advised to take note of the detrimental long-term effect of takeover bids that accrues in spite of short-term gains. Post-merger integration management is costly in both financial terms as well as time and effort. Nonetheless, positive long term CARs are possible and management would be doing well in studying our cross-sectional results for determinants of long-term M&A success.

2.5 Conclusions

ARCH effects in OLS-based event studies can have a material impact on abnormal return calculations which can be corrected using GARCH modelling. In a first-time application of GARCH correction in M&A, this chapter addressed four research questions: (1) Are there ARCH effects when conducting M&A event studies in the UK? (2) Can models from the GARCH family help ameliorate the estimation problems of OLS when ARCH effects are present? (3) Are the resulting abnormal returns different from standard event studies when using ARCH models? and (4) Do these differences translate to variations in CAR cross-sectional models?

An ARCH-Lagrange Multiplier (LM) test with up to five lagging days for the detection of ARCH effects led to the detection of ARCH problems in 50.76% of modelled events. In events with ARCH effects, we tested a range of GARCH family models, i.e., GARCH, eGARCH and tGARCH of the order (1, 1) to model the ARCH effects. This approach sufficed for an inclusion of 96.04% of events. In our sample, OLS seemed to overestimate betas when ARCH effects were present, leading to a significant difference in both short- and long-term abnormal returns where the GARCH-adjusted event study returned greater but still negative, results compared to OLS (-20.09% in OLS vs. -15.95% when correcting for ARCH over two years for the full sample). These differences did not lead to a significant difference in predictors of either short- or long-term abnormal returns. Consistent with some UK-based literature, we found positive short-term abnormal returns around the announcement date (0.86% with pure OLS and 0.90% with GARCH correction within five days of announcement) and long-term negative abnormal returns.

Contributions to the literature are made by providing a more detailed assessment of bidding firm abnormal returns. Importantly, our results provide verification of previous examinations of abnormal return drivers, while upwardly-correcting the extent to which bidding stocks and acquirer shareholders are losing value. We collected valuable evidence for the number of ARCH effects present in daily UK stock data.

One or two suggestions can be made to improve on these results in future studies. One improvement might lie in the averaging process of abnormal returns. For instance, if small bidders overreact, value-weighted averages might produce a different interpretation. The timing of announcement could also be further examined, as we found some evidence of announcements on short-term market upswings. Future research might also seek to replicate our methodology to gather evidence on abnormal return creation in other markets. Finally, events with ARCH effects display more negative abnormal returns than events without ARCH effects. This trend indicates possible future research, for example, examining whether ARCH effects serve as an indicator of negative returns, during and following M&A announcements.

Chapter 3

Agency Costs in the Market for Corporate Control: Evidence from UK Takeovers

3.1 Introduction

The market for corporate control operates as a disciplinary mechanism which both pressures managers to make decisions in the best interests of shareholders and acts as the 'court of last resort' when other corporate governance systems fail (Kini, Kracaw & Mian 2004, p 1512, citing Jensen 1987). Through price pressure and imminent threats of takeover, stock markets are a key instrument for disciplining management and reducing agency costs (Manne 1965). The purpose of this chapter is to test whether agency costs predict takeover likelihood and if the takeover mechanism disciplines inefficient management. We address two main questions: (1) How effective is the market for corporate control in an economy with an open merger policy? and (2) What agency cost indicators are associated with market discipline? By answering these questions, we determine the extent to which takeover likelihood is related to the market for corporate control and agency costs. Rather than forecasting takeover probabilities on a case by case or aggregate basis, we determine the factors, in particular, which variables relate to agency costs, that lead to market participants identifying a company as a takeover target.

Dispersed ownership, index investing strategies and free rider problems lead shareholders to rely on buy and sell decisions instead of monitoring management. Exit (the decision to sell) famously dominates the voice mechanism in market-based systems of governance (Jensen & Ruback 1983). A stock's value reflects the value of the management of company assets (Manne 1965) and if values are lower than could be achieved by a more efficient management team, the company becomes a takeover target. After the takeover, inefficient management will be removed and the stock price restored to the true value. According to Manne (1965), downward pressure on stock prices resulting from shareholders' decisions to sell their stock follow from inefficient management of assets and are reflected in the market value. Any deviation from the true value due to inefficient management are agency costs, that is, costs arising from the separation of ownership and control Jensen & Meckling (1976). Therefore, if agency costs for a given company surpass a certain threshold, the company is expected to become a takeover target. In this chapter, a disciplinary takeover is defined as a takeover that occurs due to increased agency costs in the target firm. We expect takeover likelihood to increase with agency costs.

While majority of empirical research on the market for corporate control focuses on abnormal returns accruing to target shareholders (Jensen & Ruback 1983), relatively few studies have examined the more specific question of whether the market disciplines firms that perform poorly due to agency costs. Studies on abnormal returns to Mergers and Acquisitions (M&A) do not usually compare disciplinary and non-disciplinary takeovers or targets and non-targets. However, takeovers may occur for non-disciplinary reasons such that the excess return is simply a reflection of increased demand for target company stock. Similarly, no definitive statement can be derived regarding the disciplinary effect of takeovers without comparison between companies that are taken over and those that are not. Such a statement can be made by modelling takeover likelihood.

This chapter contributes to the literature on takeover likelihood, disciplinary takeovers and agency costs. While the connection between takeover likelihood and the market for corporate control has been made in previous studies (for example Dickerson, Gibson & Tsakalotos 2002, Kini et al. 2004), our study adopts a more explicit agency theory framework than previous studies of takeover likelihood, or indeed of excess returns to M&A. A key component of our contribution follows from differentiating candidates for disciplinary takeovers from other forms of M&A. The methodology adopted by Dickerson et al. (2002) focusses on classifying cases with respect to Jensen's definition of agency costs of free cash flow 1986. Our approach is to identify candidates for disciplinary takeover on the basis of excess return and Tobin's Q (TQ), which is more consistent with the approach advocated by Manne (1965). We then examine how indicators of agency costs affect takeover likelihood within the disciplinary set. Our results reveal that the definition applied in Dickerson et al. (2002) is not effective in identifying disciplinary takeovers and confirm the relationship between disciplinary takeovers and agency cost indicators.

Our findings help explain the workings of one of the central mechanisms for rectifying systemic and company specific agency costs. We find strong support for the impact of pre-bid stock return and valuation on takeover likelihood. Firms that experience a significant fall in share price have a significantly higher takeover likelihood. However, we find no association with agency costs for these takeovers. Stock price falls alone do not indicate a disciplinary effect as stock price effects may indicate a correction to the market value rather than agency costs. Such an effect may arise simply due to investor sentiment. When we extend the analysis to takeovers with a low market value relative to the replacement costs of assets (our definition of disciplinary candidates), results indicate that agency cost indicators are associated with takeover likelihood. Asset utilisation and sales growth exhibit positive associations with takeover likelihood while profitability was negatively associated with the risk of takeover for the disciplinary set.

For the non-disciplinary takeovers in our sample, company fundamentals had only a limited association with takeover likelihood. Given the UK context of our study, in which anti-takeover provisions are disallowed, and when compared to findings of US studies, our results imply support for the effectiveness of an open merger policy if regulators desire a functional market for corporate control.

The remainder of the chapter is organised as follows: We continue to review the relevant literature on takeover likelihood and agency costs in Section 3.2. We then present the hypotheses for this study in Section 3.3. Issues relating to data collection and takeover likelihood modelling are discussed in Section 3.4. Section 3.5 includes the empirical results and a discussion of the findings. The final section provides concluding comments.

3.2 Literature

3.2.1 Takeover Likelihood and the Market for Corporate Control

Takeover likelihood studies have provided insight into the type of companies that are more likely to be taken over. (Manne 1965) discussed the mechanism by which poorly performing managers may be removed via the takeover mechanism. He described this phenomenon as 'the market for corporate control'. The pressure from the market may be sufficient to motivate managers to act in the best interest of shareholders. Inefficiently managed companies should, in this framework, become takeover targets. Poorly performing management should be removed and new, more efficient management installed. Shareholders are then protected from agency costs because if companies perform sufficiently poorly with the assets of the company, the price increases either as a result of bidding or by increases in the stock price associated with the new and more efficient management.

If the market for corporate control is effective, we expect takeover likelihood to increase if management is observably underperforming. Several variables may indicate the presence of agency costs. While agency costs are not directly measurable, they are approximated through indicators, often in correlation with measures of the strength of a firm's corporate governance. Prime indicators identified in the literature are firm valuation, profitability, sales growth, firm size, cost- and sales efficiency, indebtedness and debt capacity, dividend payments and levels of investment. For instance, higher profitability or market valuation indicate lower levels of agency costs. While it is possible that agency costs and high operating performance may be simultaneously present, such costs are a problem only when shareholders do not receive their required rate of return. Similarly, higher stock returns indicate lower levels of agency costs (Jensen & Meckling 1976, Jensen 2001). Empirical results are mixed. Powell & Yawson (2007) and Loderer & Waelchli (2015) found that excess returns are positively associated with takeover probability. Alternatively, Agrawal & Jaffe (2003) observed no relationship between stock returns and takeover risk, whereas Dickerson et al. (2002) reported evidence for higher takeover likelihood in low profitability firms.

With agency costs coming at the expense of shareholder wealth, a higher firm valuation is an indication of lower agency costs (Jensen & Meckling 1976). One measure of valuation, TQ, has been shown to increase with smaller boards (Yermack 1996) and optimisation of board size for the complexity of firms, such that simple firms require small boards and more complex firms need larger board with more outside directors (Coles, Daniel & Naveen 2008). Similarly, there is evidence of higher valuations, as measured by Tobin's Q and the book to market ratio, for firms with stronger shareholder rights (Gompers, Ishii & Metrick 2003). Tobin's Q has been shown to increase with managerial ownership, until ownership reaches a critical point where entrenchment is possible, and to increase with institutional ownership (Doukas, Kim & Pantzalis 2000).

Tobin's Q has also been applied as an indicator of growth problems in studying agency costs of free cash flow. Jensen (1986) demonstrated that agency costs are associated with free cash flows. High free cash flows in the absence of growth projects may indicate high agency costs (Jensen 1986, McKnight & Weir 2009). Jovanovic & Rousseau (2002) view high Tobin's Q as a driver of acquisition activity. Tobin's Q has been regressed against combined firm CARs in Aktas et al. (2010) without reporting results. There is some evidence for a negative effect of TQ on short-term bidder cumulative abnormal returns (CARs) (Bao & Edmans 2011), and of smaller long-term bidding company CARs for firms with a high price earnings ratio (Sudarsanam & Mahate 2003). In contrast, Hackbarth & Morellec (2008) find a significant positive effect of the book to market ratio on long-term bidder CARs.

Several studies have also examined whether growth opportunities are associated with takeover risk. However, these studies fail to reach consensus. Greater sales growth reflects lower agency costs. Sales growth is higher for firms with stronger shareholder rights (Gompers et al. 2003). Sales growth decreases with inside ownership and increases with institutional ownership (Doukas et al. 2000). Sales growth can also lower takeover likelihood (Loderer & Waelchli 2015), even though some studies, for example Powell & Yawson (2007), directly examine the effect of variables which might be expected to be associated with company growth such as sales growth and free cash flow on takeover likelihood but find no significant effect. Sales growth, valuation multiples, liquidity and leverage can indicate imbalances between growth opportunities and company resources (Palepu 1986, Powell & Yawson 2007). The value of a company with high growth prospects but limited access to necessary resources could be fully realised if that organisation were to be acquired by a bidder with suitable resources. Consistent with this view, Palepu (1986) reported higher takeover risk for firms identified as having a growth-resource imbalance.

Other studies more directly examined the relationship between growth opportunities, company valuation and takeover hazard. Bates, Becher & Lemmon (2008) and Cremers, Nair & John (2008) observed a small but significant negative effect of Tobin's Q on takeover likelihood, indicating that as growth opportunities increased, the risk of takeover was marginally reduced. On the other hand, Rhodes-Kropf, Robinson & Viswanathan (2005) observe a positive association between the market-to-book ratio and takeover likelihood, which is inconsistent with an agency cost explanation. Both Palepu (1986) and Ambrose & Megginson (1992) found no measurable effect for Tobin's Q.

In a study with similarities to the present study, Dickerson et al. (2002) tested Jensen's free cash flow hypothesis by examining the level of investment, dividend payment and leverage of high and low Tobin's Q firms compared to other firms. On average, higher investments lead to a lower takeover risk regardless of the level of Tobin's Q, while there was no relationship between Q and either dividend payments or leverage. In addition, investment levels of low Q firms were negative, offering no support for the free cash flow hypothesis (Jensen 1986). Also, Edmans, Goldstein & Jiang (2012) estimated the discount implied by the difference between the potential, optimal firm valuation and market value. While the authors find strong support for an active role of capital markets in a takeover, it is not clear whether the discount was due to agency costs or mispricing.

Similar to firm value, profitability can be expected to be higher for low agency cost firms. Higher profitability, in terms of return on equity, for firms with stronger shareholder rights (Gompers et al. 2003). There is evidence for a positive effect of profitability on TQ (Yermack 1996, Coles et al. 2008) and on the insider fraction on board (Coles et al. 2008), a negative effect of profitability on board size (Coles et al. 2008). One study has found a positive effect of profitability on short-term bidder CARs (Bao & Edmans 2011). Profitability is higher for firms with smaller boards, and larger firm size (Yermack 1996). Likelihood of becoming a takeover target is lower for more profitable firms in Dickerson et al. (2002), but higher in Loderer & Waelchli (2015).

The asset utilisation ratio and expense ratio have been applied as agency cost proxies, such that lower asset utilisation and higher expense ratio reflect higher agency costs. Asset utilisation has been demonstrated to increase with equity ownership by management (Angwin 2000, Singh & Davidson III 2003 and limited evidence in McKnight & Weir 2009) and to decrease with Chief Executive Officer (CEO) tenure (McKnight & Weir 2009).[1] Similarly, the expense ratio has been shown to decrease with higher managerial ownership (Ang et al. 2000, non-significant effect in Singh & Davidson III 2003). Asset utilisation is decreasing with board size and increasing with director ownership and firm size (Yermack 1996). Both ratios have not yet been applied in econometric studies of takeover likelihood.

The level of debt is another variable expected to put pressure on management to use resources more efficiently (Jensen 1986, Harvey, Lins & Roper 2004, Berger & Bonaccorsi di Patti 2006, King & Santor 2008, Margaritis & Psillaki 2010). Therefore, higher levels of debt should be associated with lower takeover probability. However, there appears to be limited support for this view in the empirical studies. Bruner (1988) reported that target firms have significantly higher leverage compared to their peers and Nuttall (1999) find that takeover likelihood increases only slightly as debt increases. Leverage was reported to have an insignificant effect on takeover likelihood in several other studies (Dickerson et al. 2002, Powell & Yawson 2007, Loderer & Waelchli 2015).

3.2.2 Agency Cost Indicators

3.2.3 Influences on Takeover Likelihood

The likelihood of becoming a takeover target has been found to be influenced by several variables. For instance, firm size is considered to have an important influence on takeover likelihood (Palepu 1986, Comment & Schwert 1995, Cooley & Quadrini 2001, Dickerson et al. 2002, Loderer & Waelchli 2015). From an agency cost perspective, larger firms are harder to monitor (McKnight & Weir 2009), their management is prone to hubris (Moeller et al. 2004, 2005) and empire building efforts (Gorton et al. 2009). Larger firms tend to be more active buyers in takeover

[1] Longer CEO tenure is indicative of entrenchment, which facilitates agency costs (Hermalin & Weisbach 1998).

markets, which supports the empire building perspective (McKnight & Weir 2009). Also, larger firms are viewed as less attractive because they have fewer potential buyers and are harder to integrate with the buyer (Cooley & Quadrini 2001). Takeover likelihood should, therefore, be greater for small firms. In contrast to this, there is evidence for a positive effect of firm size on asset utilisation (Yermack 1996, McKnight & Weir 2009), profitability (Yermack 1996) and profit margin (Yermack 1996) as well as sales growth (Doukas et al. 2000). Palepu (1986) and Comment & Schwert (1995) find that the expected negative relationship while others reported a positive effect (Dickerson et al. 2002, Loderer & Waelchli 2015).

Takeover risk also decreases as firms mature. Mature firms often have lower profitability and fewer growth opportunities, making them less attractive to bidders (Loderer & Waelchli 2015, Loderer, Stulz & Waelchli 2016). Such firms have lower levels of investment in research and development and higher post-merger integration costs. These firms may also have lower corporate governance standards and higher agency costs as a result (Loderer & Waelchli 2015). For younger, smaller firms, exit risk is a particular concern (Bhattacharya, Borisov & Yu 2015). The 10-year survival rate for newly listed firms is just above 50%, with the main exit reason being takeover (Fama & French 2004). Notably, Shumway (2001) find no empirical evidence of a relationship between company age and risk of bankruptcy.

A commonly expressed hypothesis is that high cash reserves invite takeover bids, especially when no growth opportunities are present (Palepu 1986). Contrary to this expectation, the literature regularly fails to report a significant relationship between liquidity and takeover likelihood (Palepu 1986, Barnes 2000, Dickerson et al. 2002). In fact, Loderer & Waelchli (2015) find that takeover likelihood is lower for companies with high cash reserves.

Two further issues are worthy of consideration. First, M&A activity tends to occur in waves (DePamphilis 2010). During merger waves, or periods of high takeover activity, takeover risk increases. These effects are closely related to economic growth and industry concentration. Both of these factors can precipitate takeover waves and economic growth is often accompanied by high investor sentiment and greater availability of funds. Loderer & Waelchli (2015) observed a significant impact of industry wide acquisition activity on takeover likelihood. Increasing industry concentration can trigger strategic competition and herding behaviour, which increases takeover likelihood. As industry concentration increases, competitors gain market share and benefit from economies of scale. Such environments can lead to 'eat or be eaten' situations where competitors race to gain market share by acquisition (Schoenberg & Reeves 1999). Powell & Yawson (2007) find that industry concentration, as measured by the Herfindahl Index, has a positive impact on takeover likelihood.[2]

Second, another strand of the literature focuses on the availability of merger partners and the influence on takeover hazard. For instance, Hoberg & Phillips (2010) examined the presence of firms with similar product ranges as a proxy for merger partner availability. The authors report significantly higher takeover likelihood when rivals to potential targets had similar product ranges, particularly if there were only a few competitors. Rhodes-Kropf & Robinson (2008) found that companies with similar market-to-book ratios were often M&A partners and Loderer & Waelchli (2015) observed a positive effect on takeover likelihood when merger partners were of similar size. Table 3.1 summarises the previous literature on takeover likelihood and highlights key variables and their effect on takeover likelihood with respective references.

3.3 Hypotheses

Consistent with Manne (1965), our prime indicator of disciplinary takeover risk is a change in market value. We test this in two ways. First, we examine the effect on disciplinary takeover risk arising from unexpected changes in the stock price and second, a change in Tobin's Q, that is, the market value relative to the replacement cost of assets. These variables are the basis of our overarching hypotheses.

[2]The Herfindahl Index is calculated as the sum of squared market shares of all competitors in a market. A higher value indicates greater industry concentration.

Table 3.1: Previous literature

Panel A: Market value		
	Study (Year)	Effect on takeover likelihood
Excess return	Powell & Yawson (2007), Loderer & Waelchli (2015)	Positive
	Agrawal & Jaffe (2003)	Non-significant
	Dickerson, Gibson & Tsakalotos (2002)	Negative
Tobin's Q	Rhodes-Kropf, Robinson & Viswanathan (2005)	Positive
	Palepu (1986), Ambrose & Megginson (1992)	Non-significant
	Bates, Becher & Lemmon (2008), Cremers, Nair & John (2008)	Negative
Stock price volatility	Loderer & Waelchli (2015)	Positive
Panel B: Firm level fundamentals		
Asset utilisation	Ang, Cole & Lin (2000), Singh & Davidson III (2003)	Negative
Expense ratio	Ang et al. (2000), Singh & Davidson III (2003)	Positive
Dividend payments	Palepu (1986), Barnes (2000), Dickerson et al. (2002)	Non-significant
Investments	Dickerson et al. (2002)	Negative
Leverage	Bruner (1988), Nuttall (1999)	Positive
	Dickerson et al. (2002), Powell & Yawson (2007), Loderer & Waelchli (2015)	Non-significant
Profitability	Dickerson et al. (2002)	Negative
	Loderer & Waelchli (2015)	Positive
Sales growth	Powell & Yawson (2007)	Non-significant
	Loderer & Waelchli (2015)	Negative
Tangible assets	Dickerson et al. (2002)	Negative
	Powell & Yawson (2007), Loderer & Waelchli (2015)	Non-significant

Notes: The table summarises variables used in previous literature together with their references, grouped by their findings for each variable's effect on takeover likelihood. Ang et al. (2000) and Singh & Davidson III (2003) are not studies of takeover likelihood, but examine the effects of ownership structure on asset utilisation and expense ratio (agency cost proxies). We demonstrate the hypothesised effect on takeover likelihood as an extension of our overarching hypothesis that agency costs drive disciplinary takeover likelihood.

Specifically, we hypothesise that a significant discount indicates high takeover risk and argue that increases in takeover likelihood following significant reductions in stock prices provide support for the effectiveness of the market for corporate control. However, given that stock price falls may be corrections to the true value of the firm, we expect agency cost indicators to be relatively weakly associated with disciplinary takeover risk. Hence, rather than using excess return for our primary hypothesis, we argue that disciplinary takeover risk is associated with Tobin's Q and Tobin's Q, in turn, is associated with agency cost indicators. Alternatively, our null hypothesis is that takeover likelihood is unaffected by changes in Tobin's Q and are thus not associated with agency costs. Such a finding indicates an ineffective market for corporate control. Thus, our primary hypotheses (H_1 and H_2) are:

H_1: Disciplinary takeover likelihood is not related to excess return.

H_2: Disciplinary takeover likelihood is negatively related to Tobin's Q.

The third hypothesis (H_3) tests whether takeover likelihood is driven by specific measures of agency costs. In this view, and again consistent with Manne (1965), agency costs drive market value discounts which in turn, activate the market for corporate control and increase takeover likelihood. We argue that it is these firm fundamentals that drive disciplinary takeovers. Hence, our third hypothesis is:

H_3: The likelihood of disciplinary takeover is positively related to agency costs.

As pointed out in the literature review in Section3.2.2, agency costs have been reported to be associated with firm-specific fundamental variables such as relative profitability (Jensen & Meckling 1976, Gompers et al. 2003, Coles et al. 2008), asset utilisation (Jensen & Meckling 1976, Ang et al. 2000, Singh & Davidson III 2003), cost management (Jensen & Meckling 1976, Ang et al. 2000, Singh & Davidson III 2003), dividend policy (Jensen 1986), leverage (Jensen 1986, McKnight & Weir 2009), unused debt capacity (Jensen 1986, Powell & Yawson 2007), investment behaviour (Jensen 1986, Yermack 1996) and growth (Jensen 1986, Singh &

Davidson III 2003, McKnight & Weir 2009). Combining H_3 with the interpretation of the aforementioned variables from the perspective of agency theory leads to the following sub-hypotheses for H_3:

H_3:

(i) Higher profitability is indicative of lower agency costs and is therefore negatively related to the likelihood of disciplinary takeover.

(ii) Greater asset utilisation reflects lower agency costs and, by extension, has a negative relation with the likelihood of disciplinary takeover.

(iii) A higher expense ratio signals higher agency costs and is consequently related to greater likelihood of disciplinary takeover.

(iv) Higher dividend payments are indicative of lower agency costs and therefore have a negative relation to the likelihood of disciplinary takeover.

(v) Greater usage of leverage is indicative of lower agency costs and is therefore negatively related to the likelihood of disciplinary takeover.

(vi) Tangibility acts as a proxy for an entity's debt capacity and thus has a similar impact on the likelihood of disciplinary takeover as leverage.

(vii) Capital expenditures can indicate greater agency costs and are therefore positively related to the likelihood of disciplinary takeover.

(viii) Greater sales growth is indicative of lower agency costs and therefore has a negative correlation with the likelihood of disciplinary takeover.

3.4 Methodology

3.4.1 Sample Characteristics

Data for this study were collected for all UK companies - excluding financial companies and utilities - which have a primary listing in London and were listed at

Table 3.2: Sample construction

Panel A: Sample development		N firms	N takeovers
Initial		4403	1630
Exclude negative sales or total assets		3659	1630
Exclude firm-year observations after a 100% takeover		3653	1557
Exclude firm-year observation with negative duration		3570	1530
Exclude companies younger than five years		2077	751
Exclude missing data		1929	704

Panel B: Final Sample	Count	% of firm-year obs.	% of distinct firms
N Firm-years	23 893		
N Distinct firms	1929		
N Takeovers of 100%	704	2.95	36.50

Notes: The table details the development of number of firm-year observations and number of takeovers in relation to inclusion criteria in Panel A. Panel B shows number of firm-year observations, number of firms, number of 100% and their ratios for the final sample. Note that some models will use a smaller sample due to further missing observations. The final sample for Panel B corresponds to model 2 from Table 3.6.

any point during 1986 to 2015. Company fundamental data were collected from Thomson Reuters DataStream and information regarding takeover bids was collected from Thomson ONE Banker. The announcement date was taken as the date of the takeover bid and the completion date was defined as the effective date of the merger or acquisition. Only successful takeovers where 100% of equity was owned by the bidder after completion were included.[3] The initial sample included 6,016 takeovers of UK public targets with 874 failed attempts. Details of the sample construction are provided in Table 3.2. Panel A lists exclusions from the sample due to missing or inadequate data regarding the number of firms and takeovers. The number of firm-year observations, firms and takeovers in the final sample are provided in Table 3.2 Panel B. Note that around one-third of sample companies were taken over.

Our specification requires identification not just of takeovers but, more specifically, of disciplinary takeovers. The methodology for TQ interaction terms used here resembles the technique applied by Dickerson et al. (2002). However, Dickerson et al. (2002) tested Jensen's (1986) free cash flow hypothesis, while we focus on Tobin's Q to test the market for corporate control. Specifically, we classify disciplinary

[3]Acquisitions of smaller percentages of control, e.g., 75%, are negligible in our sample. See Figure B.1 in Appendix B.

takeover by identifying companies that have underperformed. We did this in two ways. First, we create dummy variables indicating any company in the lowest group for a given quantile of an industry-year group for excess return and Tobin's Q. For the initial analysis, we use the median, terciles, quartiles and deciles. Results were strongest for the deciles of industry-year groups and, therefore, we used deciles (*d q decile*) for the main analysis.

Other firm-specific variables were standardised by industry-year group and we use ICB industry classifications to identify industry groupings. All models include lagged values for estimation of current takeover hazard. We also control for several variables that are expected to affect takeover likelihood with the explanatory variables. We include market-wide variables such as industry concentration, takeover intensity and macroeconomic growth in the estimation along with firm-specific factors such as the availability of similarly sized and valued competitors as previous studies have demonstrated that these factors are relevant to takeover risk (Loderer & Waelchli 2015). Variable definitions are listed in Table 3.3.[4]

3.4.2 Cox Proportional Hazards (Cox PH) Model

While traditional takeover likelihood literature relies on probit or logistic models (Palepu 1986, Ambrose & Megginson 1992), more recent studies have used survival analysis (Dickerson et al. 2002, Loderer & Waelchli 2015). Interestingly, a similar methodological shift has been observed in the bankruptcy prediction literature (Shumway 2001).

Survival models respect the panel nature of the data. As such, models from the survival family do not face the matching problem inherent in traditional limited

[4]An important issue with the model we use is the basis for calculating duration. We calculate duration as the difference in years between financial year end and the first available year of data or the date of the most recent relevant event. The earliest available year of data for UK companies in DataStream is 1964. Accordingly, our data were effectively winsorised such that all companies are considered to have been established in that year. Only about 9% of all companies were established in 1964 and of these, 53% were successfully taken over. In contrast, of the companies established after 1964, only 34% were acquired. See Figures B.2 and B.3 in Appendix B.

Table 3.3: Variable definitions

Panel A: Market value

Variable	Definition
excess r	Difference between stock return and market return for the 12 months ending at financial year end. Returns are calculated on basis of DataStream's return index.
q	(Market value of equity plus total debt) divided by total assets
volatility	Standard deviation of monthly stock returns for the last 12 months ending at latest full month before or on financial year end
d excess r decile	1 if firm-year observation is in bottom decile of its industry-year group for excess r
d q decile	1 if firm-year observation is in bottom decile of its industry-year group for q

Panel B: Firm specific fundamentals

Variable	Definition
duration	Difference between financial year end and BDATE in full years
asset utilisation	Net sales divided by average of beginning- and end-of-year book values of Total Assets.
expense ratio	Operating expense divided by Net sales. Winsorisation is increased to 2.75% on the right side for the removal of extreme values.
div on assets	Cash dividends paid divided by average of beginning- and end-of-year book values of Total Assets
investment	Capital Expenditure (CAPEX) divided by average of beginning- and end-of-year book values of Total Assets
leverage	End-of-year book value Total Debt divided by end-of-year book value of Total Assets. Winsorisation is increased to 0.50% on the right side to remove outliers.
roa	Earnings before Interest and Taxes (EBIT) divided by average of beginning- and end-of-year book values of assets
sales growth	Net sales divided by previous year's net sales minus one. Winsorisation is increased to 0.30% on the right side to remove extreme values.
tangible	End of year Property, Plant and Equipment (PPE) divided by end-of-year book value of assets.

Panel C: Control variables

Variable	Definition
ln mva	Natural logarithm of (Market value of equity plus book value Total Debt)
mtb similarity	Number of companies with similar market to book ratio from the same industry-year group divided by total number of companies in the group. Similarity is assumed for all peers with market to book ratios within 0.25 standard deviations of the company in question.
size similarity	Number of similar sized companies from the same industry-year group, divided by total number of companies in the industry-year group. Similar size is assumed for companies with a market value of equity within 0.15 standard deviations of the company in question.
intensity	Number of other companies from the same industry-year group that get taken over, divided by total number of other companies in the industry-year group
herfindahl	Sum of squared Net sales figures for all companies of the industry-year group. The top 2.5% percentile is excluded from the group to prevent misclassification (Giroud & Mueller 2010, Loderer & Waelchli 2015).
gdp growth	Year on year real GDP growth
start	A binary variable that is 1 for all companies that are present in the first year of the panel and 0 otherwise (See Figures B.2 and B.3 in Appendix B).

Notes: The table details the calculation of all variables. Firm-level variables were standardised by industry-year group. All unbound continuous variables were winsorised at 0.25% on each side to remove outliers unless a different degree is indicated.

dependent variable models such as logit models or probit models. In such models takeover cases need to be matched with non-takeover cases which implies that choice-based sampling is necessary. This sampling process, in turn, introduces a bias into the model (Palepu 1986). Additionally, by maintaining the panel structure of the data, survival models incorporate the time-dependence of firm-year observations within firm groups (Dickerson et al. 2002).[5] Survival analysis accomplishes this, by modelling takeover likelihood conditional on survival up unto that point in time. Finally, survival analysis allows for censoring of data, which means that firms can leave the sample for reasons other than takeover. This enriches the data set by adding information that otherwise would be lost (Klein & Moeschberger 2005).

We used the Cox Proportional Hazards (Cox PH) model to estimate the effect of our explanatory variables (see Table 3.3) on takeover hazard. The initial Cox PH model was defined as follows:

$$h(t|x, y, z) = h_0(t) \exp(\beta \prime x + \gamma \prime y + \epsilon \prime z) \tag{3.1}$$

where $h(t|x, y, z)$ is the hazard at time t conditional on vectors of covariates x, y and z, $h_0(t)$ is the baseline hazard which, in the case of Cox PH, is non-parametric and β, γ and ϵ are the vectors of coefficients to be estimated.x is a vector of firm-level, market-value-based variables, y is a vector of firm-level fundamental variables and z is a vector of firm-, industry and macro-level control variables. Covariates are lagged by one period. All models incorporate firm-specific (clustered) fixed effects. We included the *start* variable in all specifications to capture possible survivorship bias for companies established before 1964.

The assumption of proportional hazard states that the effect of a covariate on hazard is proportional over time, i.e., the covariate introduces a constant relative hazard. We tested this assumption by requiring a non-zero slope in a generalised linear regression of scaled Schoenfeld residuals over a function of duration (Schoenfeld

[5]A firm's current year values are influenced by last year's values.

1982). Where the assumption was violated, we attempted to restore proportionality by including an interaction term between the problematic covariate and duration.

To address the second research question, we interacted low excess return and low Tobin's Q dummies with the firm-specific fundamental variables:

$$h(t|d_x, y, d_x y, z) = h_0(t) \exp(\beta\prime d_x + \gamma\prime y + \delta\prime d_x y + \epsilon\prime z) \tag{3.2}$$

where in addition to the variables in Equation 3.1, d_x is a dummy variable indicating cases of either excess return or Tobin's Q in the bottom decile of the firm's industry-year group. δ is the vector of coefficients for the interaction terms between d_x and y.

3.4.3 Accelerated Failure Time (AFT) Model

As a robustness test, we compared the Cox PH results to those of an Accelerated Failure Time model with an assumed Weibull distribution. In log-linear form, such a model can be written as:

$$\ln T = \mu - (\beta\prime d_x + \gamma\prime y + \delta\prime d_x y + \epsilon\prime z) + \sigma W \tag{3.3}$$

where $\ln T$ is the log of failure time, μ is the mean failure time and $\beta\prime d_x + \gamma\prime y + \delta\prime d_x y + \epsilon\prime z$ is the acceleration factor. σW is the error term and W describes the error term distribution. We assumed a Weibull distribution. The coefficients are logs of survival time ratios and the interpretation of coefficient signs is the opposite of that of a Cox PH model, i.e., a positive sign indicates a longer survival time.

3.4.4 Logistic Regression (Logit) Model

An additional robustness test was drawn from logistic regression (logit) modelling.

$$P(i) = \frac{1}{1 + \exp -(\beta d_x + \gamma y + \delta d_x y + \epsilon z + u_i)} \tag{3.4}$$

where, in addition to previously defined variables $P(i)$ is the probability of firm-year i receiving a successful takeover bid in the next period and u_i is the error term to the logistic regression.

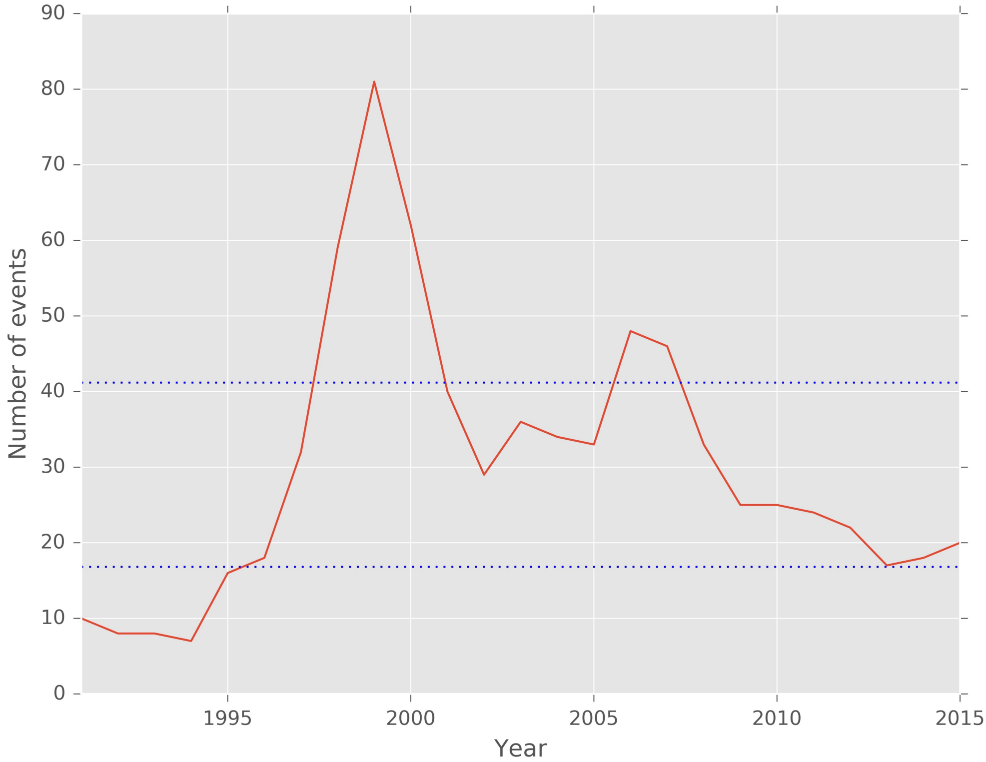
3.4.5 Descriptive Statistics

Figure 3.1 depicts the number of successful 100% acquisitions in the final sample. The graph reveals the somewhat wavelike appearance of merger activity. The first wave starts to build in the mid-1980s and reaches a peak in 1989. The second wave builds rapidly to a peak at the height of the dot-com boom in 1999 before rapidly declining. The third wave begins around 2004, the peak is reached in 2007 and then declines as the UK economy struggled with the aftermath of the Global Financial Crisis.

Table 3.4 lists the descriptive statistics for the independent variables used in this chapter. We used the average of the beginning-of-year and end-of-year financial data for the denominator for all flowing variables (for example Return on Assets (ROA)). To control for outlying observations, we winsorise unbound continuous variables at 0.25%, unless stated otherwise (see Table 3.3). Note that volatility was not included in the interaction models due to its association with market-value-based variables. The sample size was set at the maximum number of observations from all later models.[6]

Correlation coefficients between the key predictors and control variables are listed in Table 3.5. Most coefficients are small but significant. The strongest correlation is

[6]A particularly notable value is the mean of 17% for *d excess r decile*, which was due to the dummies being created as early as possible in the data set development (i.e., at step *Initial* in Table 3.2) to include the maximum amount of information. A robustness test with the excess r dummy was calculated in the latest step, and therefore, a mean of 10% was added in Table B.1 (see Appendix B).



The blue lines indicate the top and bottom 20% quantiles for the number of takeovers.

Figure 3.1: Number of takeovers per year in final sample

Table 3.4: Descriptive statistics

	N	mean	std	min	median	max
div on assets	20 255	0.03	0.03	0.00	0.02	0.34
investment	23 149	0.06	0.07	0.00	0.04	0.65
leverage	23 893	0.19	0.20	0.00	0.15	1.52
excess r	22 404	−0.11	0.54	−2.79	−0.05	1.75
volatility	23 893	0.12	0.08	0.00	0.10	0.61
asset utilisation	23 291	1.28	0.93	0.00	1.15	6.81
expense ratio	22 789	1.11	0.89	0.35	0.94	7.02
roa	23 155	0.02	0.28	−2.95	0.08	0.69
sales growth	22 766	0.31	2.03	−1.00	0.08	33.83
tangible	23 742	0.30	0.24	0.00	0.26	0.96
mva	23 893	931.83	4651.24	0.58	58.19	60 233.82
mtb similarity	23 893	0.20	0.11	0.00	0.21	0.50
size similarity	23 893	0.44	0.29	0.00	0.48	0.94
intensity	23 893	0.01	0.01	0.00	0.01	0.06
herfindahl	23 893	0.05	0.08	0.01	0.02	0.72
gdp growth	23 893	0.02	0.02	−0.06	0.03	0.07
d excess r decile	23 893	0.17	0.38	0.00	0.00	1.00
d q decile	23 893	0.10	0.30	0.00	0.00	1.00

Notes: Variable definitions are in Table 3.3. Market value of assets (mva) is in £mn.

-0.78, which is between firm size (*ln mva*) and similarly sized merger partners (*size similarity*). Another strong coefficient is -0.69 between *excess r* and *d excess r decile*, which are not simultaneously included in any given model. Few other coefficients exceed 0.3.

3.5 Results and Discussion

In this section, we present the results of the Cox PH analysis. First, we describe baseline models and then introduce the controls. We begin by assessing the impact of stock performance and Tobin's Q on takeover likelihood, as listed in Table 3.6. We then interact the lowest decile variables, indicating disciplinary takeover risk, with our independent variables which indicate the potential presence of agency costs (Table 3.7). Tables 3.8 and 3.10 include details of further analyses and robustness checks using the Accelerated Failure Time (AFT) model, comparing different interaction dummy definitions and an analysis of cases with low valuation and low profitability.

3.5.1 Excess Return, Tobin's Q and Takeover Likelihood

Table 3.6, models 1 and 2 and list the results of the Cox PH models using firm-specific external (market-value) indicators as predictors. The first column presents the model, including excess return and controls. In the second column, we replace excess return with Tobin's Q. Results for market value-related variables are largely consistent with the hypothesised effects on takeover likelihood; excess returns and valuation multiples are negatively related to takeover likelihood, i.e., takeover likelihood increases with lower performance and company valuation. These findings hold when explanatory variables were combined with firm-level fundamental variables and controls in model 5.

Our results contradict previous studies. Specifically, Powell & Yawson (2007) and

Table 3.5: Correlation coefficients

	(1) excess r	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(2) q	0.06***								
(3) volatility	−0.23 ***	0.08***							
(4) div on assets	0.09***	0.27***	−0.21 ***						
(5) investment	0.06***	0.10***	−0.07 ***	0.08***					
(6) leverage	−0.14 ***	0.04***	0.12***	−0.17 ***	0.05***				
(7) asset utilisation	0.08***	−0.02 ***	−0.05 ***	0.13***	−0.01	−0.07 ***			
(8) expense ratio	−0.14 ***	−0.11 ***	0.15***	−0.20 ***	−0.10 ***	0.08***	0.11***		
(9) roa	0.30***	−0.03 ***	−0.30 ***	0.39***	0.11***	−0.21 ***	0.16***	−0.44 ***	
(10) sales growth	0.06***	0.07***	0.02***	−0.03 ***	0.08***	−0.01 **	0.02***	−0.04 ***	0.05***
(11) tangible	0.00	−0.08 ***	−0.10 ***	−0.06 ***	0.44***	0.16***	−0.21 ***	−0.12 ***	0.02***
(12) ln mva	0.16***	0.07***	−0.27 ***	0.22***	0.11***	0.11***	−0.05 ***	−0.19 ***	0.26***
(13) mtb similarity	−0.01	−0.49 ***	−0.08 ***	−0.18 ***	−0.04 ***	−0.11 ***	−0.12 ***	0.02***	0.04***
(14) size similarity	−0.13 ***	−0.08 ***	0.18***	−0.19 ***	−0.05 ***	−0.05 ***	0.05***	0.12***	−0.17 ***
(15) intensity	−0.03 ***	−0.01	−0.03 ***	0.00	−0.01	0.00	0.00	−0.01	0.01
(16) herfindahl	0.00	0.01**	−0.01 **	0.00	0.02***	0.00	0.00	−0.06 ***	0.01
(17) gdp growth	0.06***	−0.01	−0.06 ***	0.00	−0.01	0.00	−0.01	0.02***	0.00
(18) d excess r decile	−0.69 ***	−0.02 **	0.37***	−0.11 ***	−0.04 ***	0.11***	−0.03 ***	0.13***	−0.27 ***
(19) d q decile	−0.08 ***	−0.22 ***	0.04***	−0.16 ***	−0.09 ***	−0.10 ***	0.04***	0.09***	−0.07 ***
	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
(11) tangible	−0.02 ***								
(12) ln mva	−0.01 *	0.13***							
(13) mtb similarity	−0.05 ***	0.10***	−0.05 ***						
(14) size similarity	0.03***	−0.06 ***	−0.78 ***	0.07***					
(15) intensity	0.00	−0.01	0.00	0.00	0.03***				
(16) herfindahl	0.02***	0.03***	0.00	0.00	0.01**	−0.16 ***			
(17) gdp growth	−0.01 *	0.00	0.00	0.00	−0.01	0.09***	−0.02 ***		
(18) d excess r decile	−0.01 *	−0.03 ***	−0.20 ***	−0.03 ***	0.15***	−0.01 *	−0.01 *	−0.03 ***	
(19) d q decile	−0.03 ***	−0.03 ***	−0.20 ***	0.05***	0.14***	0.00	0.01	0.00	0.07***

Notes: The table shows Pearson correlation coefficients between the indicated variable pairs. Variable definitions in Table 3.3. *p<0.1; **p<0.05; ***p<0.01. Number of observations between variable pairs are differing due to missingness of data. We use the highest possible number of observations for each pair.

Table 3.6: Cox PH models

	Market Value		Firm level fundamentals		Combined
	(1)	(2)	(3)	(4)	(5)
excess r	−0.220***				−0.202***
	(0.034)				(0.040)
q		−0.465***			−0.340**
		(0.107)			(0.138)
volatility	0.705***	0.817***			0.874***
	(0.082)	(0.079)			(0.095)
asset utilisation			0.001	0.030	0.029
			(0.053)	(0.054)	(0.055)
expense ratio			0.053	−0.144	−0.239
			(0.221)	(0.206)	(0.195)
div on assets			−0.049	0.010	−0.041
			(0.062)	(0.061)	(0.068)
investment			0.131	0.132	0.163
			(0.120)	(0.110)	(0.121)
leverage			0.114	0.230	0.095
			(0.144)	(0.139)	(0.143)
roa			−0.223***	−0.117	0.075
			(0.081)	(0.088)	(0.097)
sales growth			−0.190	−0.052	−0.081
			(0.216)	(0.195)	(0.191)
tangible			0.020	0.019	0.025
			(0.051)	(0.051)	(0.108)
start	−1.862***	−1.862***	−2.671***	−1.936***	−1.759***
	(0.143)	(0.139)	(0.128)	(0.147)	(0.155)
ln mva	0.228***	0.257***		0.127*	0.164**
	(0.063)	(0.062)		(0.073)	(0.075)
mtb similarity	0.133**	0.030		0.477***	0.311
	(0.054)	(0.056)		(0.127)	(0.132)
size similarity	0.310***	0.297***		0.234***	0.250***
	(0.053)	(0.051)		(0.055)	(0.058)
intensity	95.437***	94.012***		113.050***	90.105***
	(6.153)	(5.997)		(6.345)	(7.070)
herfindahl	6.151***	6.524***		7.222***	6.058***
	(0.923)	(0.907)		(1.067)	(1.109)
gdp growth	38.930***	41.455***		14.352***	59.386***
	(5.046)	(4.991)		(2.657)	(6.587)
N	22 407	23 893	20 076	19 938	18 514
Number of events	658	704	586	586	548
R^2	0.056	0.056	0.027	0.049	0.060
Max. Possible R^2	0.408	0.412	0.404	0.406	0.406
Log Likelihood	-5229.550	-5660.306	-4920.394	-4699.875	-4245.276
Wald Test	1390.070***	1446.520***	413.740***	1149.490***	1191.920***
LR Test	1301.470***	1366.708***	552.772***	992.351***	1153.128***
Score (Logrank) Test	1415.186***	1446.747***	646.523***	1240.250***	1315.819***

Notes: The table shows Cox PH models for market value based variables and controls in columns 1 and 2, Cox PH models for firm level fundamental variables in columns 3 and 4 and a Cox PH model combining all variables in column 5. Variable definitions are in Table 3.3. Models 1 and 2 contain interaction terms of volatility, gdp growth, intensity and herfindahl with duration. Models 3 and 4 contain interaction terms of investment, leverage, sales growth, tangible, intensity and gdp growth with duration. Panel C contains interaction terms of duration with volatility, investment, sales growth, tangible, intensity and gdp growth. This is for the protection of Cox PH assumptions. *p<0.1; **p<0.05; ***p<0.01. Standard errors in parentheses.

Loderer & Waelchli (2015) find a significant positive effect on takeover likelihood and Agrawal & Jaffe (2003) report no relationship between takeover likelihood and stock performance. The negative impact of Tobin's Q in our study is consistent with findings of Bates et al. (2008) and Cremers et al. (2008). To an extent, our results contradict Rhodes-Kropf et al. (2005) who find a positive effect of the market-to-book ratio on takeover likelihood.

Volatility, which can be interpreted as higher price uncertainty, had a positive effect on takeover likelihood in our models. It might reasonably be expected that risk-averse bidders would prefer lower volatility. One explanation for this finding is that volatility presents potential acquirers with an opportunity to launch their bid. Such opportunities may be related to agency costs, especially considering we control for industry-year fixed effects.

It is interesting to note that firm size similarity had a positive effect on takeover likelihood in our sample. Also notable are the large coefficients for takeover intensity and real GDP growth. The need to control for survivorship bias was confirmed by significant positive coefficients for the start dummy in all models. Overall, the results in models 1 and 2 listed in Table 3.6 are consistent with the market for corporate control explanation and indicate that takeover likelihood is related to falling stock prices and company valuations.

3.5.2 Takeover Likelihood and Firm Fundamentals

Firm-specific fundamental variables had little effect on takeover likelihood. Table 3.6 provides details of models 3 and 4 depicts Cox PH models based on internal firm-specific variables. The first column (model 3) presents the baseline model, including firm-specific fundamental variables. Firm-specific, industry and economy level controls were added to the model (2), as shown in the second column (model 4). Model 5 combines the fourth model (4) with the explanatory variables from models 1 and 2. The only internal variable with a significant, and in this case, negative coefficient was return on assets (*roa*). However, the significance disappears when industry and macro-wide controls are included. All other internal variables are non-significant across all models.

The results are consistent with several other studies of takeover likelihood. The insignificant effect of leverage on takeover risk is consistent with Dickerson et al. (2002), Powell & Yawson (2007) and Loderer & Waelchli (2015) but contrary to positive impacts found in Bruner (1988) and Nuttall (1999). Dickerson et al. (2002) also reported a negative relationship between takeover likelihood and capital expenditure, which we cannot confirm. However, our results are consistent for return on assets (positive) and dividends (insignificant). Powell & Yawson (2007) finding that sales growth is not related to takeover likelihood is also confirmed.

The lack of significance of firm fundamentals on takeover likelihood is slightly surprising and, therefore, lead to the next step of the analysis. Theoretical arguments for the superior predictive power of market-based variables are present in the bankruptcy forecasting literature (Agarwal & Taffler 2008). Under the assumption of market efficiency, asset prices should contain all information that can be extracted from financial statements, including any identifiable risk of takeover or bankruptcy. Perhaps the lack of significance in our sample is due to firm fundamentals containing little of such information, whereas market values are more informative. It could be that information received after the last accounting date is more pertinent to such risks. However, we propose another view. We argue that most takeovers are not disciplinary, and the effect of firm fundamentals is expected to be different for disciplinary and non-disciplinary takeovers. These effects may be offset in general models. Our next step is, therefore, to distinguish between disciplinary and non-disciplinary takeovers. Given that we find decreases in stock price and company valuation increase takeover likelihood, we next consider whether firm fundamentals, and in particular agency costs, drive takeover likelihood for companies that have underperformed in the previous 12 months.

3.5.3 Disciplinary Takeovers and Agency Costs

Manne (1965) states that if a company's market value falls relative to the value that could be achieved under a more efficient management team, the company is likely to become a takeover target. This mechanism does not require any change in fundamentals, only a change in value. The logical next step is to ask what drives acquisition likelihood within those companies that experience the steepest price discounts and are thus the strongest candidates for disciplinary takeovers. To investigate this issue, we interact company fundamentals with a binary variable that indicated firm-year observations in the bottom decile of excess return and Tobin's Q for firm's industry-year group. Table 3.7 shows the results of the models of takeover likelihood, including the disciplinary dummy that indicated the lowest decile for excess return - or Tobin's Q - and internal firm fundamentals.

Our second hypothesis posits that takeover likelihood increases as agency costs increase. Agency costs are not directly observable but have been found to be related to several firm-specific variables (see Table 3.1). We hypothesise that these variables are related to takeover likelihood for disciplinary takeovers. By interacting the firm-specific indicators of agency costs with the disciplinary dummy, we confirm that takeover likelihood can be predicted by such fundamental variables.

In Table 3.7, our initial interest is in the interaction between firm fundamentals and the disciplinary dummy variable (*d excess r decile*). The lowest decile dummy was significant in all models for the excess return specification of disciplinary takeover but not when disciplinary takeovers were identified using the lowest decile for Tobin's Q. Firm fundamentals appear to have only a weak relation to takeover likelihood in models 1 to 3, with the exception of the expense ratio, which had the correct sign for agency costs. In models 5 and 6, the Tobin's Q interaction was insignificant while agency cost indicators were significant. Several specific interactions were identified as significant from our agency costs indicators and consistent with the market for corporate control hypotheses.

Table 3.7: Firm level fundamental/market value interaction

	Excess Return			Tobin's Q		
	(1)	(2)	(3)	(4)	(5)	(6)
asset utilisation	0.005	0.017	−0.004	0.008	−0.039	−0.010
	(0.053)	(0.059)	(0.059)	(0.053)	(0.060)	(0.061)
expense ratio	0.043	−0.128	−0.239	0.053	0.054	−0.125
	(0.220)	(0.241)	(0.227)	(0.220)	(0.237)	(0.218)
div on assets	−0.044	−0.078	−0.013	−0.055	−0.098	−0.036
	(0.062)	(0.071)	(0.069)	(0.063)	(0.068)	(0.067)
investment	0.050	0.050	0.100	0.048	0.063	0.116
	(0.133)	(0.137)	(0.126)	(0.133)	(0.133)	(0.122)
leverage	0.064	0.038	0.090	0.066	0.077	0.140*
	(0.071)	(0.084)	(0.084)	(0.071)	(0.074)	(0.074)
roa	−0.196**	−0.240**	−0.137	−0.228***	−0.130	−0.012
	(0.084)	(0.104)	(0.107)	(0.081)	(0.092)	(0.097)
sales growth	−0.173	−0.174	−0.065	−0.180	−0.281	−0.183
	(0.214)	(0.220)	(0.198)	(0.216)	(0.219)	(0.205)
tangible	0.168	0.213	0.116	0.170	0.155	0.056
	(0.109)	(0.113)	(0.106)	(0.108)	(0.109)	(0.104)
d market	0.221**	0.311**	0.384***	−0.077	−0.211	−0.251
	(0.108)	(0.120)	(0.121)	(0.145)	(0.221)	(0.221)
start	−2.632***	−2.639***	−2.059***	−2.650***	−2.676***	−1.941***
	(0.129)	(0.129)	(0.146)	(0.129)	(0.129)	(0.148)
ln mva			0.126*			0.109
			(0.072)			(0.073)
mtb similarity			0.487**			0.433**
			(0.131)			(0.126)
size similarity			0.240***			0.237***
			(0.054)			(0.055)
intensity			113.023***			113.091***
			(6.247)			(6.368)
herfindahl			−0.043			7.145***
			(0.775)			(1.080)
gdp growth			14.514***			14.299***
			(2.681)			(2.658)
asset utilisation:d market		−0.037	−0.026		0.331**	0.268*
		(0.136)	(0.137)		(0.142)	(0.142)
expense ratio:d market		0.698	0.802*		−0.210	−0.148
		(0.490)	(0.484)		(0.619)	(0.603)
div on assets:d market		0.173	0.104		0.263*	0.248
		(0.138)	(0.146)		(0.162)	(0.169)
investment:d market		−0.016	−0.043		−0.089	0.034
		(0.168)	(0.168)		(0.310)	(0.304)
leverage:d market		0.102	0.112		−0.241	−0.308
		(0.154)	(0.155)		(0.339)	(0.326)
roa:d market		0.152	0.147		−0.766***	−0.746***
		(0.181)	(0.194)		(0.208)	(0.215)
sales growth:d market		0.004	0.027		0.597**	0.523*
		(0.237)	(0.226)		(0.187)	(0.201)
tangible:d market		−0.190	−0.215		−0.023	−0.065
		(0.134)	(0.135)		(0.193)	(0.194)
d market		d excess r decile			d q decile	
N	20 076	20 076	19 938	20 076	20 076	19 938
Number of events	586	586	586	586	586	586
Number of events in d market	118	118	118	57	57	57
R^2	0.027	0.028	0.047	0.027	0.028	0.049
Max. Possible R^2	0.404	0.404	0.406	0.404	0.404	0.406
Log Likelihood	-4917.220	-4913.826	-4716.457	-4919.100	-4907.722	-4690.152
Wald Test	429.300***	442.440***	1178.190***	417.810***	440.340***	1167.130***
LR Test	559.121***	565.909***	959.187***	555.360***	578.117***	1011.796***
Score (Logrank) Test	655.418***	661.390***	1245.531***	649.260***	672.286***	1253.358***

Notes: The table shows Cox PH models including a dummy that indicates the bottom decile for excess r in Panel A and a dummy that indicates the bottom decile for TQ in Panel B. Variable definitions in Table 3.3. Panel A contains interaction terms of investment, tangible, sales growth, mtb similarity and intensity with duration. Panel B contains interaction terms of investment, tangible, sales growth, intensity and herfindahl with duration. *p<0.1; **p<0.05; ***p<0.01. Standard errors in parentheses.

When the expense ratio was interacted with the excess return specification of the disciplinary dummy, a slightly significant positive coefficient was observed in model 3. Among the firms that experienced the lowest levels of excess return and essentially, falling stock prices, those with poor cost discipline were more likely to be taken over. While it could be argued that such companies should be unattractive for bidders, our perspective is that these companies experience agency costs and do not have a sufficiently strong position to resist takeover. Companies in the lowest decile for excess return and with higher expense ratios are associated with a higher risk of being taken over, implying, in our framework, that bidder management likely expects to be able to improve cost discipline and returns. Other interactions between the lowest decile dummy for excess return and firm fundamentals returned no significance.

We use Tobin's Q rather than excess return to identify disciplinary takeovers for our formal test of hypothesis 2, while all other model specifications remained unchanged. Hence, the disciplinary dummy represents companies in the lowest decile of Tobin's Q. Contrary to results in models 1 to 3, the disciplinary dummy itself was insignificant in all three models. However, the interaction terms between the disciplinary dummy and firm fundamentals exhibit significance for several variables.

Specifically, a notably strong effect, which was consistent across all models, was identified on return on assets (*roa*), as detailed in Table 3.7, Panel B. Takeover hazard decreases as the company's return on assets increases for companies in the lowest decile of TQ. The finding for return on assets was consistent with the view that these companies may have minimal leeway for performance improvement if the market accurately values the current efforts of management, i.e. the agency costs. Also, weaker performance regarding return on assets attracts disciplinary takeovers.

When compared to Panel A of Table 3.7, we find a significant effect of sales growth on takeover likelihood. When disciplinary takeovers were classified using the lowest decile of Q rather than excess return, the sales growth (*d q decile:sales growth*) became positive, specifically, as sales growth increases takeover risk also increases. Similar effects on takeover likelihood were associated with asset utilisation and when ignoring controls dividend payments. Asset utilisation (*d q decile:asset utilisation*) increased takeover likelihood in both models with slightly greater significance in model 5. Similarly, dividends (*d q decile:div on assets*) were associated with increased takeover risk in model 5 only. Consistent with our hypothesis, higher asset utilisation was associated with higher takeover risk for companies in the lowest decile for Tobin's Q.

Within the market for corporate control framework, the results in Table 3.7 can be summarised as follows: sales growth, asset utilisation and, to a limited degree, dividends raise the likelihood of becoming a target for a disciplinary takeover. Also, return on assets has a negative effect on disciplinary takeover likelihood. Each of these variables were consistent with our hypotheses regarding the firm-specific variables. These results are more intuitive when considering that previous studies have examined takeover likelihood rather than disciplinary takeover likelihood. Concerning low TQ firms, i.e. underperforming firms, potential bidders appear to be selective with regards to asset utilisation, sales growth and profitability. In this case, low TQ indicates the presence of agency costs. On the other hand, a one-year price fall may be a correction to the stock price rather than an indicator of agency costs.

The negative coefficient for return on assets for the low TQ firms provides further support for our hypothesis. This finding is consistent with expectations in the literature for takeover likelihood summarised in Table 3.1. For the low TQ set, higher profit might be expected to attract bidders because these candidates may be undervalued. Low Q firms with high return on assets indicate an opportunity for more efficient management to improve performance, as proposed by (Manne 1965). In this case, both low Q and low profitability indicate agency costs and increase disciplinary takeover likelihood. Similarly, when profit is low but other indicators such as sales growth or asset utilisation are high, agency costs may be constraining performance and such companies would be expected to become candidates for a disciplinary takeover in a market for corporate control framework.

If our definition of disciplinary takeovers used is accepted, our results provide strong support to Manne's (1965) market for corporate control argument. Notably, a declining stock price does not imply that a company is cheap. The discounted stock price may move the company valuation towards the true value and if the efficient market hypothesis holds, there is no reason for these companies to become takeover targets. However, if the company is subject to agency costs and, as Manne (1965) explains, a more efficient management team could enhance stock price, it is expected that beyond a given threshold, the company is likely to become a takeover target. One of the strongest indications of agency costs is that company value has deviated from potential value. In our study, Tobin's Q appears to be a strong indicator of the presence of agency costs and takeover likelihood.

3.5.4 Robustness Tests

We perform two robustness checks to confirm our findings. First, we repeat the Cox PH model using an Accelerated Failure Time (AFT) model. This test confirms the preceding results. As a second robustness test, we check the appropriateness of our choice to use the lowest decile of Tobin's Q. Extending our specification inevitably reduced the significance of the agency cost indicators but by broadening the analysis to larger quantiles for the low Tobin's Q set, we were able to observe the reduction in sensitivity of takeover likelihood to the interaction terms between firm fundamentals and the disciplinary dummy. In our main tests, we use the lowest decile of Tobin's Q in industry-year clusters. In our robustness tests, we examine Cox PH models where we extend the definition of candidates for disciplinary takeover from the lowest 10% of Tobin's Q to the lowest 15%, 20%, 30% and 40%. The following two subsections provide further detail of these robustness tests.

Accelerated Failure Time Model with Weibull Distribution

Table 3.8 repeats selected models from Tables 3.6 and 3.7. The interpretation of AFT coefficients is the opposite to that in a Cox PH model, that is, a positive coefficient indicates longer survival. Importantly, the results were consistent with previous findings. Increases in both excess return and Q lead to longer survival time in models 1 and 2. TQ was not significant in model 4 where all controls are included. Firm-level fundamentals are not significant, with the exception of leverage when excluding market-value-based variables in model 3 and the TQ interaction model (6). In model 5, consistent with Table 3.7, the dummy for the lowest excess return decile was significant but the interaction terms were insignificant, with the exception of expense ratio. When using the indicator of the lowest decile for Q, the disciplinary dummy was significant positive at 10%, which is in contrast to the results listed in Table 3.7. Consistent with previous findings, interaction terms between sales growth and asset utilisation and the disciplinary dummy lead to shorter survival (higher takeover likelihood), while return on assets is associated with longer survival.

Logistic Regression Models

Table 3.9 presents the results from Table 3.6 and Table 3.7 modelled in logistic regression (logit). The interpretation of the coefficients from a logit model is similar to that in a Cox-PH model, in that a positive sign indicates increased probability of takeover. In line with previous results, the logit models found a negative effect from the continuous versions of excess return and TQ on takeover likelihood (models 1, 2 and 4). Also, firm level fundamental variables had little relation to takeover likelihood, with sales growth being an exception (models 3 and 4). In the interaction models (5 and 6), the lowest decile for excess return was significant positive, with no relation to firm level fundamentals. The same dummy based on TQ was insignificant with interaction terms confirming previous results (ROA negative, asset utilisation and sales growth positive). Additionally there was a positive interaction term between low TQ and dividends, which previously had dissipated when includ-

Table 3.8: Accelerated failure time models with Weibull distribution

	(1)	(2)	(3)	(4)	(5)	(6)
excess r	0.083***			0.077***		
	(0.012)			(0.013)		
q		0.104***		0.065		
		(0.037)		(0.045)		
volatility	0.023	−0.006		0.019		
	(0.019)	(0.020)		(0.022)		
asset utilisation			−0.002	−0.005	−0.008	0.014
			(0.023)	(0.022)	(0.024)	(0.025)
expense ratio			0.002	0.027	0.083	0.004
			(0.088)	(0.089)	(0.088)	(0.093)
div on assets			−0.006	0.003	−0.0002	0.008
			(0.020)	(0.022)	(0.022)	(0.022)
investment			−0.010	−0.020	−0.011	−0.009
			(0.023)	(0.023)	(0.025)	(0.023)
leverage			−0.046*	−0.025	−0.038	−0.049*
			(0.028)	(0.030)	(0.031)	(0.028)
roa			0.039	−0.005	0.036	0.001
			(0.031)	(0.034)	(0.038)	(0.034)
sales growth			0.034	0.047	0.029	0.066
			(0.051)	(0.045)	(0.062)	(0.051)
tangible			−0.006	0.002	−0.019	−0.006
			(0.021)	(0.022)	(0.023)	(0.022)
d market					−0.098**	0.127*
					(0.042)	(0.077)
start	0.998***	1.022***	0.987***	0.975***	0.986***	0.982***
	(0.036)	(0.036)	(0.038)	(0.039)	(0.038)	(0.038)
ln mva	−0.048**	−0.053**	−0.022	−0.026	−0.023	−0.016
	(0.024)	(0.025)	(0.027)	(0.028)	(0.027)	(0.028)
mtb similarity	−0.026	−0.003	−0.035	−0.016	−0.035	−0.029
	(0.023)	(0.024)	(0.026)	(0.029)	(0.026)	(0.025)
size similarity	−0.097***	−0.097***	−0.079***	−0.077***	−0.077***	−0.080***
	(0.020)	(0.020)	(0.021)	(0.021)	(0.021)	(0.021)
intensity	−13.097 ***	−14.018 ***	−13.007 ***	−12.121 ***	−13.197 ***	−12.826 ***
	(0.997)	(0.978)	(1.037)	(1.072)	(1.045)	(1.035)
herfindahl	−0.228	−0.167	−0.182	−0.134	−0.164	−0.186
	(0.281)	(0.292)	(0.322)	(0.330)	(0.322)	(0.319)
gdp growth	−4.201***	−4.074***	−5.417***	−5.612***	−5.468***	−5.399***
	(0.827)	(0.841)	(0.931)	(0.931)	(0.936)	(0.930)
asset utilisation:d market					0.019	−0.112**
					(0.045)	(0.046)
expense ratio:d market					−0.355**	0.066
					(0.169)	(0.199)
div on assets:d market					−0.026	−0.061
					(0.042)	(0.048)
investment:d market					0.009	0.030
					(0.054)	(0.107)
leverage:d market					−0.020	0.110
					(0.056)	(0.126)
roa:d market					−0.036	0.301***
					(0.061)	(0.070)
sales growth:d market					0.002	−0.185*
					(0.091)	(0.095)
tangible:d market					0.071	0.010
					(0.052)	(0.073)
Constant	3.901***	3.956***	3.961***	3.948***	3.990***	3.955***
	(0.052)	(0.054)	(0.053)	(0.058)	(0.056)	(0.053)
d market					d excess r decile	d q decile
N	22 407	23 893	19 938	18 514	19 938	19 938
Number of events	658	704	586	548	586	586
Number of events in d market					118	57
Scale	0.347	0.355	0.344	0.338	0.344	0.342
Log(Scale)	-1.059***	-1.034***	-1.068***	-1.083***	-1.068***	-1.072***
Log Likelihood	-4190.077	-4507.121	-3800.436	-3535.863	-3794.876	-3789.165
χ^2	1010.133***	1033.487***	844.991***	828.414***	856.111***	867.532***

Notes: The table shows AFT models repeating the final specifications from Table 3.6 and Table 3.7 Panels A and B. Variable definitions are in Table 3.3. d market is a place holder for the variables d excess r decile and d q decile in the last two models. *p<0.1; **p<0.05; ***p<0.01. Standard errors in parentheses.

ing controls in Cox PH modelling. Uninteracted firm level fundamental variables, again, did not relate to takeover likelihood, with the exception of sales growth and tangibility. In sum, the logistic model results are confirming previous findings of a relation between low TQ, agency costs, and takeover likelihood.

Sensitivity to Redefining Quantiles for Disciplinary Takeovers

The results listed in Table 3.10 provide support for the use of low Tobin's Q as an indicator of disciplinary takeover likelihood, the choice of threshold used in our primary tests (Table 3.7) and the association between takeover likelihood and agency cost indicators. Our findings are largely consistent with the 20% threshold and begin to moderate beyond it. Our results also indicate that using the median as the threshold, as in Dickerson et al. (2002), does not capture the desired effects. The general trend observed in Table 3.10 compared to Table 3.7 is that the significance of explanatory interaction terms dissipates as we relax the thresholds for disciplinary takeover candidates. The significance of profitability, asset utilisation and sales growth declines as the disciplinary takeover set is extended. The only irregularity was the slight significance on interaction terms for dividend payments and investment at the 20% dummy. Consistent with a free cash flow agency cost perspective (Jensen 1986), the interaction term on investment is positive, indicating the possibility for a bidder to decrease or redirect the capital expenditure of a target that seems to be investing at below its cost of capital. The positive interaction term for dividends is difficult to explain from an agency cost perspective and might simply represent the purchase of strong dividend payers at low valuations.

Sensitivity to Redefining Controlling Acquisitions

It might be possible that there is an influential number of acquisitions that lead to controlling acquisitions that result in at least 50%, but less than 100% ownership in target firm equity.[7] Accordingly, Table 3.11 presents a robustness test for relax-

[7]For visual evidence see the graph in Figure B.1 in the Appendix.

Table 3.9: Logistic regression models

	(1)	(2)	(3)	(4)	(5)	(6)
excess r	−0.164***			−0.154***		
	(0.033)			(0.040)		
q		−0.531***		−0.480***		
		(0.100)		(0.128)		
volatility	0.055	0.111**		0.122**		
	(0.048)	(0.045)		(0.057)		
asset utilisation			0.062	0.058	0.078	0.019
			(0.051)	(0.052)	(0.057)	(0.057)
expense ratio			−0.085	−0.175	−0.094	−0.012
			(0.146)	(0.151)	(0.162)	(0.156)
div on assets			−0.013	−0.004	−0.013	−0.050
			(0.061)	(0.066)	(0.068)	(0.065)
investment			−0.093	−0.032	−0.095	−0.091
			(0.061)	(0.063)	(0.066)	(0.062)
leverage			0.096	0.023	0.086	0.109
			(0.067)	(0.073)	(0.079)	(0.069)
roa			−0.054	0.113	−0.070	0.034
			(0.082)	(0.096)	(0.104)	(0.089)
sales growth			−0.240**	−0.284***	−0.205**	−0.319***
			(0.094)	(0.104)	(0.104)	(0.106)
tangible			0.086*	0.061	0.127**	0.087*
			(0.049)	(0.052)	(0.055)	(0.051)
d market					0.383***	−0.134
					(0.121)	(0.210)
start	−0.020	−0.135*	−0.105	−0.087	−0.088	−0.104
	(0.084)	(0.081)	(0.087)	(0.092)	(0.088)	(0.088)
ln mva	0.317***	0.344***	0.187**	0.242***	0.202***	0.184**
	(0.065)	(0.063)	(0.074)	(0.076)	(0.074)	(0.075)
mtb similarity	0.222***	0.080	0.215***	0.092	0.210***	0.201***
	(0.053)	(0.055)	(0.060)	(0.065)	(0.060)	(0.060)
size similarity	0.204***	0.189***	0.137**	0.149**	0.134**	0.140**
	(0.054)	(0.052)	(0.057)	(0.059)	(0.057)	(0.057)
intensity	31.854***	31.628***	29.974***	29.326***	29.964***	29.554***
	(3.311)	(3.273)	(3.592)	(3.638)	(3.603)	(3.604)
herfindahl	−0.914	−1.046*	−0.702	−0.919	−0.664	−0.757
	(0.615)	(0.612)	(0.705)	(0.735)	(0.705)	(0.709)
gdp growth	5.078**	5.462***	8.154***	8.750***	8.240***	8.219***
	(2.091)	(2.048)	(2.412)	(2.517)	(2.419)	(2.414)
asset utilisation:d market					−0.074	0.279**
					(0.127)	(0.138)
expense ratio:d market					−0.003	−0.639
					(0.386)	(0.447)
div on assets:d market					0.003	0.331*
					(0.147)	(0.176)
investment:d market					−0.013	−0.008
					(0.167)	(0.272)
leverage:d market					−0.034	−0.303
					(0.149)	(0.313)
roa:d market					0.193	−0.676***
					(0.186)	(0.232)
sales growth:d market					−0.093	0.423**
					(0.222)	(0.183)
tangible:d market					−0.197	−0.008
					(0.128)	(0.182)
Constant	−4.134***	−4.165***	−4.145***	−4.310***	−4.223***	−4.142***
	(0.106)	(0.103)	(0.109)	(0.124)	(0.113)	(0.110)
d market					d excess r decile	d q decile
N	22 407	23 893	19 938	18 514	19 938	19 938
Number of events	658	704	586	548	586	586
Number of events in d market					118	57
Log Likelihood	-2880.395	-3078.256	-2577.403	-2381.296	-2570.142	-2569.318
Akaike Inf. Crit.	5780.791	6176.512	5186.806	4800.591	5190.283	5188.637

Notes: The table shows logit models repeating the final specifications from Table 3.6 and Table 3.7 Panels A and B. Variable definitions are in Table 3.3. d market is a place holder for the variables d excess r decile and d q decile in the last two models. *p<0.1; **p<0.05; ***p<0.01. Standard errors in parentheses.

Table 3.10: Low TQ dummy definition test

	(1)	(2)	(3)	(4)
asset utilisation	−0.007	−0.047	−0.075	−0.041
	(0.063)	(0.068)	(0.078)	(0.085)
expense ratio	−0.131	−0.107	−0.145	−0.164
	(0.212)	(0.219)	(0.236)	(0.263)
div on assets	−0.048	−0.053	−0.025	−0.047
	(0.067)	(0.068)	(0.070)	(0.076)
investment	0.099	0.093	0.108	0.131
	(0.124)	(0.124)	(0.124)	(0.129)
leverage	0.279*	0.266*	0.285*	0.297*
	(0.138)	(0.140)	(0.143)	(0.149)
roa	0.023	0.031	0.040	0.037
	(0.099)	(0.103)	(0.115)	(0.125)
sales growth	−0.165	−0.115	−0.100	−0.131
	(0.192)	(0.186)	(0.193)	(0.211)
tangible	−0.002	0.011	−0.006	−0.030
	(0.104)	(0.105)	(0.107)	(0.113)
d market	−0.129	−0.007	0.152	0.214*
	(0.167)	(0.138)	(0.114)	(0.106)
start	−1.849***	−1.848***	−1.857***	−1.849***
	(0.147)	(0.147)	(0.148)	(0.148)
ln mva	0.112	0.109	0.124	0.133*
	(0.074)	(0.074)	(0.074)	(0.074)
mtb similarity	0.428**	0.417**	0.416**	0.417**
	(0.126)	(0.126)	(0.128)	(0.129)
size similarity	0.225***	0.224***	0.218***	0.212***
	(0.055)	(0.056)	(0.056)	(0.056)
intensity	92.498***	92.858***	92.962***	92.798***
	(6.905)	(6.920)	(6.912)	(6.898)
herfindahl	6.099***	6.119***	6.139***	6.151***
	(1.104)	(1.103)	(1.099)	(1.100)
gdp growth	65.781***	65.742***	66.052***	65.951***
	(6.429)	(6.421)	(6.434)	(6.439)
asset utilisation:d market	0.220*	0.261**	0.215*	0.117
	(0.128)	(0.115)	(0.108)	(0.109)
expense ratio:d market	0.112	0.011	0.110	0.071
	(0.504)	(0.463)	(0.407)	(0.391)
div on assets:d market	0.241	0.270*	0.153	0.210
	(0.172)	(0.157)	(0.148)	(0.129)
investment:d market	0.252	0.252*	0.121	0.030
	(0.160)	(0.147)	(0.134)	(0.127)
leverage:d market	−0.287	−0.047	−0.046	−0.056
	(0.250)	(0.204)	(0.159)	(0.142)
roa:d market	−0.572***	−0.500***	−0.314*	−0.253
	(0.185)	(0.184)	(0.175)	(0.175)
sales growth:d market	0.389	0.281	0.167	0.156
	(0.195)	(0.197)	(0.195)	(0.191)
tangible:d market	0.054	−0.017	0.037	0.068
	(0.153)	(0.131)	(0.107)	(0.103)
d market	d q 15	d q 20	d q 30	d q 40
N	19 938	19 938	19 938	19 938
Number of events	586	586	586	586
Number of events in d market	89	128	218	295
R^2	0.054	0.054	0.054	0.054
Max. Possible R^2	0.406	0.406	0.406	0.406
Log Likelihood	-4641.845	-4642.271	-4645.832	-4646.579
Wald Test	1178.340***	1152.610***	1146.790***	1150.550***
LR Test	1108.410***	1107.558***	1100.436***	1098.943***
Score (Logrank) Test	1307.919***	1307.387***	1301.414***	1300.028***

Notes: The table shows Cox PH models repeating model 6 from Table 3.7 while relaxing the TQ dummy definition to the lowest 15%, 20%, 30% and 40%. Variable definitions are in Table 3.3. The figure behind the d market descriptor indicates the top percentile at which the indicator function operates. All models contain interactions of investment, leverage, tangible, sales growth, mtb similarity, intensity, herfindahl and gdp growth with duration in order to protect the proportional hazards assumption. *p<0.1; **p<0.05; ***p<0.01 Standard errors in parentheses.

Table 3.11: Low TQ dummy definition test on basis of all controlling acquisitions

	(1)	(2)	(3)	(4)	(5)
asset utilisation	−0.023	−0.020	−0.058	−0.099	−0.056
	(0.059)	(0.061)	(0.065)	(0.075)	(0.081)
expense ratio	−0.037	−0.030	−0.001	−0.033	−0.004
	(0.210)	(0.218)	(0.226)	(0.243)	(0.277)
div on assets	−0.038	−0.044	−0.051	−0.016	−0.034
	(0.065)	(0.066)	(0.068)	(0.070)	(0.075)
investment	0.064	0.038	0.034	0.051	0.076
	(0.115)	(0.118)	(0.118)	(0.118)	(0.121)
leverage	0.264*	0.268*	0.259*	0.286*	0.293*
	(0.128)	(0.128)	(0.131)	(0.132)	(0.137)
roa	−0.052	−0.046	−0.031	−0.016	−0.009
	(0.088)	(0.090)	(0.093)	(0.104)	(0.112)
sales growth	−0.207	−0.191	−0.173	−0.163	−0.186
	(0.108)	(0.109)	(0.111)	(0.118)	(0.139)
tangible	0.077	0.074	0.087	0.071	0.057
	(0.100)	(0.101)	(0.101)	(0.103)	(0.109)
d market	−0.238	−0.145	−0.019	0.123	0.182
	(0.213)	(0.158)	(0.131)	(0.111)	(0.103)
start	−1.852***	−1.848***	−1.848***	−1.862***	−1.855***
	(0.142)	(0.142)	(0.142)	(0.143)	(0.143)
ln mva	0.085	0.087	0.084	0.101	0.112
	(0.071)	(0.072)	(0.072)	(0.071)	(0.071)
mtb similarity	0.114	0.114	0.106	0.107	0.105
	(0.059)	(0.059)	(0.059)	(0.060)	(0.061)
size similarity	0.221***	0.226***	0.225***	0.223***	0.216***
	(0.054)	(0.054)	(0.054)	(0.054)	(0.054)
intensity	112.460***	112.234***	112.543***	112.592***	112.507***
	(6.181)	(6.175)	(6.193)	(6.191)	(6.171)
herfindahl	7.409***	7.412***	7.402***	7.514***	7.579***
	(0.995)	(0.994)	(0.993)	(0.989)	(0.989)
gdp growth	11.732***	11.780***	11.781***	11.784***	11.641***
	(2.465)	(2.461)	(2.459)	(2.462)	(2.460)
asset utilisation:d market	0.202	0.174	0.223*	0.216*	0.103
	(0.139)	(0.127)	(0.113)	(0.105)	(0.105)
expense ratio:d market	0.028	0.115	−0.033	0.078	−0.061
	(0.578)	(0.495)	(0.454)	(0.404)	(0.395)
div on assets:d market	0.265*	0.266*	0.297**	0.155	0.191
	(0.161)	(0.159)	(0.144)	(0.140)	(0.125)
investment:d market	−0.113	0.223	0.221	0.087	−0.020
	(0.314)	(0.166)	(0.149)	(0.133)	(0.123)
leverage:d market	−0.160	−0.206	0.031	−0.057	−0.031
	(0.317)	(0.250)	(0.199)	(0.155)	(0.137)
roa:d market	−0.652***	−0.520***	−0.475***	−0.310*	−0.280*
	(0.211)	(0.178)	(0.172)	(0.161)	(0.160)
sales growth:d market	0.469	0.323	0.203	0.138	0.141
	(0.199)	(0.207)	(0.201)	(0.194)	(0.184)
tangible:d market	−0.081	−0.002	−0.083	0.001	0.031
	(0.188)	(0.151)	(0.129)	(0.105)	(0.100)
d market	d q 10	d q 15	d q 20	d q 30	d q 40
N	19 472	19 472	19 472	19 472	19 472
Number of events	620	620	620	620	620
Number of events in d market	59	90	132	227	309
R^2	0.051	0.051	0.051	0.050	0.050
Max. Possible R^2	0.431	0.431	0.431	0.431	0.431
Log Likelihood	-4 981.448	-4 982.247	-4 981.939	-4 985.130	-4 986.271
Wald Test	1 189.860***	1 192.850***	1 174.950***	1 162.370***	1 169.970***
LR Test	1 015.681***	1 014.084***	1 014.700***	1 008.317***	1 006.035***
Score (Logrank) Test	1 254.939***	1 252.518***	1 253.096***	1 249.312***	1 247.053***

Notes: The table shows a robustness test using Cox PH models based on Table 3.10 with acquisitions that lead to 50% of target equity acting as the event identifier, where the analysis in the main text used 100%. From left to right, the TQ dummy definition is relaxed from the lowest 10% to 15%, 20%, 30% and 40%. Variable definitions are in Table 3.3. The figure behind the d market descriptor indicates the top percentile at which the indicator function operates. All models contain interactions of investment, leverage, tangible, intensity and herfindahl with duration in order to protect the proportional hazards assumption. *p<0.1; **p<0.05; ***p<0.01 Standard errors in parentheses.

ing the definition of a takeover event to 50% of target firm equity owned after a transaction.

The number of events was slightly larger compared to the models in the main analysis (620 vs. 586 events). Similarly, for each cutoff, the number of events within the *d market* identifier was marginally greater than before. The models in Table 3.11 support the findings from the main analysis. The result for the interaction term with ROA was now significant for all cutoffs, when the finding was previously insignificant at the 40% cutoff. Still, the significance level for ROA is decreasing with relaxation of the *d market* definition. The interacted asset utilisation now followed a more erratic progression in that it was only beginning to be significant at the 20% cutoff while it was significant from 10% to 30% in the main analysis. While sales growth was previously significant positive in the lowest decile definition, it was insignificant in all cases in this robustness test. Instead, interacted dividends were now significant positive from 10% to 20%, when they were significant positive at the 20% cutoff only. Consequently, the overall story remains valid that agency costs indicators do have an impact on the lower TQ cases and that the median TQ cutoff is not sufficient.

3.5.5 Discussion and Implications

The importance of the market for corporate control should not be underestimated. In any market-based system in which allocative efficiency relies on market valuations and shareholder primacy underpins corporate governance, the market for corporate control is the 'court of last resort' (Jensen 1987, Kini et al. 2004). Perhaps this point was best captured by Manne (1965) when he stated that 'Only the takeover scheme provides some assurance of competitive efficiency among corporate managers and thereby affords strong protection to the interests of vast numbers of small, non-controlling shareholders' (p 113). In this study, we set out to answer two questions regarding the market for corporate control and takeover likelihood: (1) How effective is the market for corporate control in an economy with an open merger policy? and (2) What agency cost indicators are associated with market discipline?

In another key insight, (Manne 1965) continues that 'The lower the stock price, relative to what it could be with more efficient management, the more attractive the takeover becomes to those who believe that they can manage the company more efficiently' (p 113). Consistent with this second insight, our first tests establish that stock price and market valuation effects drive takeover likelihood. We then examine whether takeover likelihood is related to more specific indicators of agency costs. As such, we contribute to the literature by identifying which companies are likely to be candidates for a disciplinary takeover and then by examining how the takeover likelihood for these firms is related to a panel of indicators of agency costs.

A functional market for corporate control guides efficient allocation of resources and as such is desirable for shareholders and society as a whole. For shareholders and corporate management, a well-functioning market for corporate control is a key mechanism for protecting investors from agency costs. Without such a mechanism, the cost of capital increases, producing serious implications for hurdle rates, the level of corporate investment and financial development in general. Previous studies using US data have demonstrated that well-performing companies are more likely to be subject to a takeover (Agrawal & Jaffe 2003, Rhodes-Kropf et al. 2005, Powell & Yawson 2007, Loderer & Waelchli 2015). Our results tell a different story. We observe higher takeover likelihood when a company's stock price falls and market valuation is low relative to its assets. In particular, we find that companies in the lowest decile for excess return are the most likely to be subject to a takeover bid irrespective of firm fundamentals, whereas companies in the lowest decile for Tobin's Q are more likely to be takeover targets conditional on certain agency cost indicators. We interpret these results as consistent with the market for corporate control hypothesis.

From our initial review of the literature (see Table 3.1), we expected the opposite sign from several of our tests of agency variables, namely that indicators of agency costs provide bidders with the opportunity to correct poor management and improve these indicators. However, the results suggest an alternative interpretation. Tobin's

Q and profitability indicate the presence of agency costs while our firm fundamentals provided evidence of underlying strength of companies most likely to be taken over. Discipline occurs when Tobin's Q is too low and other indicators are stronger. In this study, asset utilisation and sales growth are the indicators of that strength. In our results, profitability was a key indicator that agency costs were present, rather than low TQ companies simply being undervalued. Consistent with our view, the lower the profit, the higher the takeover likelihood of companies in the low Q set. Companies with lower asset utilisation or sales growth had a lower probability of takeover. Companies with higher profit and, by extension, lower agency costs were also less likely to be taken over. The implication for practitioners is that disciplinary takeover likelihood in our sample can be inferred from the analysis of the ratio of Tobin's Q to asset utilisation, sales growth and profitability.

Given that anti-takeover provisions are disallowed in the UK, our results can be interpreted as support for the effectiveness of an open merger policy. In any market where corporate governance by boards is in question, our results suggest that an open merger policy is preferable. In other markets which allow takeover defences (such as the US for example), company managers could decide to deactivate anti-takeover provisions, as a form of bonding, to signal corporate control of agency costs. Shareholders may be willing to pay a premium for such companies in markets where takeover provisions are allowed. Removing anti-takeover defences has been previously proposed in the literature as a means to enhance takeover likelihood (Bebchuk, Coates IV & Subramanian 2002). Where takeover defences are in place, shareholders forgo potential returns that accrue if potential bidders are not deterred by defence mechanisms (See, for example, Masulis, Wang & Xie 2007 and Bebchuk, Cohen & Ferrell 2008). Yet, other studies have found anti-takeover provisions effective in improving bargaining power during M&A negotiations (conditional on the takeover going ahead) when target boards are outsider dominated (Brickley, Coles & Terry 1994). While our results do not directly imply that shareholders should seek the abolition of anti-takeover provisions, the findings do suggest that further investigation is warranted.

The market for corporate control does not simply act as a disciplinary mechanism but also puts pressure on managers to act in the best interests of shareholders. Our indicators provide direct evidence of this pressure. Specifically, Tobin's Q is a strong indicator of the presence of agency costs in the market for corporate control. Sales growth, asset utilisation and return on assets were also found to be associated with agency costs in our framework. Managers of potential targets wishing to understand the risk of a disciplinary takeover can take heed of the indicators we provide and use them as a guide for reducing disciplinary takeover risk (if not performance directly). Such indicators also provide avenues for future research. One such suggestion is to compare the results of our study to experiences of disciplinary takeover likelihood in other markets that allow such protections from takeover. In addition, further work should examine the valuation implications of voluntarily rejecting anti-takeover provisions. Furthermore, examining disciplinary takeover likelihood during periods of high takeover intensity more formally may produce interesting findings.

Finally, we argue that a functioning market for corporate control and an open merger policy are desirable for society. Allocative efficiency and economic performance are enhanced when the pricing of stocks reflects the value placed on assets by market participants. Resources are most effectively allocated and exit is facilitated when valuations are accurate. An ineffective market for corporate control and anti-takeover provisions result in inefficient allocation of society's scarce resources. In such a market, value-destroying firms and projects are allowed to continue unimpeded.

3.6 Conclusion

We examined the effectiveness of the market for corporate control in the UK and draw implications for shareholders, managers, regulators and researchers. The aim of the study was to initially answer two broad questions: (1) How effective is the market for corporate control in an economy with an open merger policy? and (2)

What agency cost indicators are associated with market discipline? Findings indicate that the most undervalued companies relative to their assets become takeover targets in the UK. Note that these results are consistent with Manne's definition of the market for corporate control (1965). Comparing our results to US takeover likelihood studies leads us to conclude that an open merger policy in which the market for corporate control is not inhibited by anti-takeover defences provides strong protection for shareholders and an effective market for corporate control. We also test whether agency costs, working through stock prices and valuation metrics, indicate the likelihood of a disciplinary takeover.

To confirm that the effects identified reflect market discipline, we compare results using two definitions of disciplinary takeover. The first specification of a disciplinary takeover is the lowest decile of excess return, which should be less related to market discipline because stock price falls may be corrections to market value rather than deviations from efficient value. The second specification, which was expected to be more strongly associated with agency costs, is the lowest decile of Tobin's Q, i.e. the lowest decile of market value to the replacement cost of assets. We then tested the association between market discipline and agency costs using interaction terms between disciplinary takeover targets and a panel of variables identified in the previous literature to indicate the presence of agency costs (Table 3.1).

When using the lowest decile for excess return to identify disciplinary targets, takeover risk increased but we found little evidence to indicate that fundamental agency cost indicators were related to takeover risk. The market was more selective regarding companies in the lowest decile of Tobin's Q. For these firms, the market favoured the disciplinary targets with potential for improved valuations. For example, we found significantly higher takeover risk for companies with higher sales growth and asset utilisation ratios within the low Q sample. These companies appear undervalued and, therefore, improved managerial efficiency is likely to enhance company value. Importantly, we also observed lower takeover risk for firms with higher profitability. This finding was important as it confirms that lower profit combined with positive information on other firm fundamentals increases disciplinary takeover risk.

Overall, given the impediments to efficient pricing resulting from anti-takeover provisions, we interpret that the market for corporate control is effective in the UK and argue that our evidence provides support for the effectiveness of an open merger policy. When market values decrease to low levels relative to the underlying assets, the market for corporate control protects shareholders. However, we caution that takeover risk is lower for companies within the low Q set and which are subject to agency costs, i.e., when both Tobin's Q and agency cost indicators are simultaneously concerning. Future research might seek to improve the measurement of replacement cost of assets in the study to more precisely identify the low Q set. Additionally, our results can be replicated in other markets, particularly in the US, a similarly market oriented economic system with good minority shareholder protection, but contrary to the UK, widespread application of anti-takeover provisions. A more specific suggestion for future work is for researchers to establish - in markets that allow anti-takeover defences - whether voluntary rejection of anti-takeover provisions can act as an effective bonding mechanism.

Chapter 4

Agency Costs of Free Cash Flow and the Market for Corporate Control

4.1 Introduction

Through the threat of takeover as an extension of price pressure, a stock market listing can act as a central mechanism for disciplining management to reduce agency costs (Manne 1965). A particular subcategory of agency costs is Jensen's agency costs of free cash flow (1986). When combining the two theories, increased threat of takeover for firms with elevated agency costs of free cash flow is expected. The objective of this study is to examine whether this takeover mechanism reduces Agency Costs of Free Cash Flow (ACFCF). This study addresses two research questions: (1) Can we identify companies with free cash flow agency problems? and (2) If yes, are such companies disciplined in takeover markets?

Our study builds on Dickerson, Gibson & Tsakalotos (2002) to further refine the methodology applied to identify companies with free cash flow agency problems. In particular, Dickerson et al. (2002) used low Tobin's Q (TQ) to address the issue of investing at below the cost of capital. However, that study ignored the free cash flow component. Therefore, Dickerson et al. (2002) method can serve to identify general agency problems but not free cash flow agency problems. We refine this methodology by requiring both low TQ and high free cash flows for the classification of a case that matches Jensen's (1986) definition. In Jensen's paper, the concept of ACFCF is developed and changes in capital structure, financial restructuring and leveraged buyouts are identified as means of decreasing ACFCF. What is not stated, however, is what mechanism motivates activation of these ameliorating activities.

The market for corporate control, according to Manne (1965), can be considered as a sequence from (a) inefficient management to (b) shareholders' decisions to sell stock to (c) a depressed stock price and finally (d) an increased likelihood of takeover. The steps from (a) to (c) describe problems resulting from the separation of ownership and control and are usually referred to as agency costs (Jensen & Meckling 1976). Accordingly, increases in agency costs above a certain hurdle lead to increased takeover likelihood.

By extension, we expect ACFCF to drive takeover likelihood, similar to more general agency costs. The problem of ACFCF is best captured in Jensen:

> Conflicts of interest between shareholders and managers over payout policies are especially severe when the organization generates substantial free cash flow. The problem is how to motivate managers to disgorge the cash rather than investing it at below the cost of capital or wasting it on organization inefficiencies. (Jensen 1986, p 323)

The rest of this chapter is organised as follows. Section 4.2 provides a review of the related literature and Section 4.3 presents the data and our econometric methodology. Section 4.4 provides a discussion of the empirical results and robustness checks and Section 4.5 offers some concluding remarks.

4.2 Literature

Agency costs of free cash flow represent costs to owners where management is unwilling to give up control over cash resources and instead invest below the firm's cost of capital (Jensen 1986). Methods for decreasing this cost are distributions to investors by means of interest expense or dividends. Increasing levels of investment would further bind capital in the firm and increase agency costs of free cash flow. Accordingly, three variables are available that allow either an increase (dividends, leverage) or decrease (capital expenditure) in cash flows to investors.

Capital Expenditure (CAPEX) and dividend payments were examined in Dickerson et al. (2002), who analyse their effect on takeover likelihood. ACFCF problems were identified based on below industry-year median TQ. However, Dickerson et al. (2002) used a simplistic framework which did not include interactions between leverage and their agency cost indicator. Results from their study reveal that regardless of Tobin's Q, higher CAPEX was associated with lower takeover likelihood while leverage and dividends are not significant.

Additional benefits of debt outside of the cash distribution perspective are increased monitoring by debt investors (Jensen & Meckling 1976) and tax deductibility of interest expense (Abel 2018). Greater levels of debt have been shown to increase asset utilisation (McKnight & Weir 2009) as well as TQ and sales growth until a certain level of debt is reached where financial risk offsets the benefits of debt (Doukas et al. 2000). McKnight & Weir (2009) have not found evidence for a reduction of agency costs of free cash flow through increased leverage. In M&A, target choice has been shown to be an alternative way of adjusting one's capital structure, so that bidder and target level of debt can become drivers of takeover activity (Uysal 2011). There is some evidence for a positive effect of leverage on takeover likelihood (Bruner 1988, Nuttall 1999), but most authors find no relation between the two variables (Dickerson et al. 2002, Powell & Yawson 2007, Loderer & Waelchli 2015). Ignoring low TQ, most studies do not find significant effects of leverage on takeover likelihood (Dickerson et al. 2002, Powell & Yawson 2007, Loderer & Waelchli 2015).

A significant positive effect for leverage on takeover likelihood is found in Bruner (1988) and Nuttall (1999). An alternative to the current level of debt is debt capacity (Lemmon & Zender 2010), which can be approximated by tangibility (Powell & Yawson 2007). Dickerson et al. (2002) have presented evidence for a negative effect of tangibility on takeover likelihood, while others find a non-significant effect (Powell & Yawson 2007, Loderer & Waelchli 2015).

Similar to the level of debt, dividends represent a commitment to distribute cash to investors and can therefore reduce agency costs of free cash flow (Jensen 1986). Most studies of takeover likelihood do not find a significant effect of dividends (Palepu 1986, Barnes 2000, Dickerson et al. 2002). Finally, the level of a firm's investment rate has been shown to have no effect on TQ (Yermack 1996), but to deter takeover attempts (Dickerson et al. 2002).

Variables outside the immediate ACFCF framework with a potential effect on takeover likelihood are stock price return (Dickerson et al. 2002, Agrawal & Jaffe 2003, Powell & Yawson 2007, Loderer & Waelchli 2015), stock price volatility (Loderer & Waelchli 2015), asset utilisation ratio (Ang et al. 2000, Singh & Davidson III 2003, McKnight & Weir 2009) and expense ratio (Ang et al. 2000, Singh & Davidson III 2003), profitability (Dickerson et al. 2002, Loderer & Waelchli 2015), sales growth (Powell & Yawson 2007, Loderer & Waelchli 2015) and tangibility (Dickerson et al. 2002, Powell & Yawson 2007, Loderer & Waelchli 2015), firm size (Palepu 1986, Comment & Schwert 1995, Cooley & Quadrini 2001, Dickerson et al. 2002, Loderer & Waelchli 2015), takeover intensity (DePamphilis 2010, Loderer & Waelchli 2015), economic growth (Loderer & Waelchli 2015), industry concentration (Schoenberg & Reeves 1999, Powell & Yawson 2007) and the availability of merger partners (Rhodes-Kropf & Robinson 2008, Hoberg & Phillips 2010, Loderer & Waelchli 2015).[1]

In our study, we expect that in a functioning market for corporate control, firms with high agency costs become candidates for disciplinary takeover (Manne 1965,

[1]For a review of these articles, see Section 3.2.

Jensen & Meckling 1976). Furthermore, we also expect that free cash flow agency problems are a form of agency costs (Jensen 1986) and, therefore, lead to higher takeover likelihood in the context of the market for corporate control. As such, we propose the following hypotheses:

> *H_1*: Companies with low growth prospects and high free cash flows are candidates for disciplinary takeovers.

A firm with agency costs of free cash flow would be able to reduce the agency problem by giving up control over the generated cash by means of distribution to either equity investors or debt investors. Such investors would then be able to redirect the freed up cash into more profitable directions (Jensen 1986). Since agency costs of free cash flow can be ameliorated by increasing payouts to investors (Jensen 1986), it follows that:

> *H_2*: Low growth/high free cash flow companies experience lower likelihood of takeover with increased payouts to investors by means of higher dividends or higher leverage.

Inverse to H_2, agency costs of free cash flow will intensify if free cash is turned into long-term assets. Greater levels of investment bind capital in the company, when investors in the firm would be better off were they able to control free cash flow towards more profitable assets or faster growing assets (Jensen 1986). In the context of the market for corporate control, a bidder could purchase such a company, decrease capital expenditures and increase cash distribution. Therefore:

> *H_3*: Low growth/high free cash flow companies are more likely to be taken over when levels of investment are high.

Table 4.1: Sample construction

Panel A: Sample development	N firms	N takeovers
Initial	4403	1630
Exclude negative sales or total assets	3659	1630
Exclude firm-year observations after a 100% takeover	3653	1557
Exclude firm-year observation with negative duration	3570	1530
Exclude companies younger than five years	2077	751
Exclude missing data	1572	594

Panel B: Final Sample	Count	% of firm-year obs.	% of distinct firms
N Firm-years	20 741		
N Distinct firms	1572		
N Takeovers of 100%	594	2.86	28.64

Notes: Panel A of the table details the progression of the number of firms and number of takeovers in the sample in relation to the stepwise enforcement of the inclusion criteria set out in Section 4.3.1. Panel B lists the number of firm-year observations, number of firms and takeovers and their ratios for the final sample. Note that all models aim to include as many observations as possible, depending on data availability. The final set presented here is for the model with the largest number of variables and, therefore, largest number of exclusion due to missingness of data.

4.3 Data and Methodology

4.3.1 Data

We acquire data on bidders and target companies from various sources, including Thomson ONE Banker and DataStream. We obtain information on all takeover bids and a longitudinal set of cross-sectional variables for UK companies that were primary listed in London at any point from 1986 to 2015, excluding financial businesses and utilities.[2] Initially, the takeover sample consisted of 6,016 takeovers of UK public targets, of which 874 were failed attempts. Table 4.1 details the construction of our sample. Panel A lists the number of firms and takeovers in the sample due to progressive removal of inadequate data, while Panel B provides the resulting ratios between the number of takeovers, firms and firm-year observations. Around a third of all companies were taken over.

Next, we classify ACFCF cases based on a firm-year observation's rank in TQ and free cash flow on assets as a proxy for ACFCF-related takeover (Dickerson et al.

[2]The relevant date for the indication of a takeover is the date of a takeover bid that results in a 100% ownership of equity by the bidder after completion.

Table 4.2: Interaction variable development

Panel A: Number of firm-year observations	median	quartile	decile
d q	10 711	5291	2063
d fcfoa	11 550	5888	2256
Combined	4730	581	44
Total firm-year obs: 20 741			
Panel B: Number of unique firms	median	quartile	decile
d q	1376	1015	588
d fcfoa	1470	1164	706
Combined	1151	308	30
Total unique firms: 1572			
Panel C: Number of takeovers	median	quartile	decile
d q	373	171	58
d fcfoa	320	136	39
Combined	170	20	0
Total Takeovers: 594			

Notes: This table details the development of the number of firm-year observations (Panel A), the number of unique firms (Panel B) and the number of takeovers (Panel C) for cases where the TQ condition, the free cash flow condition and the union of both is 1. The table compares the cut-off conditions at the median, the quartile and the decile. The sample is the final sample from Table 4.1. Variables definitions are in Table 4.3.

2002). We require Tobin's Q to be below a certain threshold and free cash flow to be above a certain threshold within industry-year groups. We tested thresholds at the industry-year median, quartiles and deciles. Table 4.2 details a count of firm-year observations, unique firms and takeovers for the three different thresholds. From this point, we dismiss the threshold at the decile as no takeovers remained (see Panel C). With only 20 takeovers from 586, the quartile method is also too restrictive.

Firm-specific continuous variables were standardised by industry-year group based on ICB industry classifications. All models used lagged values for estimation of takeover hazard. We control for several variables which may affect takeover likelihood. We included market-wide variables such as industry concentration, takeover intensity and macroeconomic growth in our estimation along with firm-specific factors such as one-year stock price performance, profitability, sales growth, tangibility and size and the availability of merger partners. These variables were considered because previous studies have demonstrated their relevance to takeover risk (see for example

Loderer & Waelchli 2015). Variable definitions are listed in Table 4.3.

An important issue with modelling takeover likelihood is the definition of company age. We defined age as the difference in years between financial year end and the first available year of data or the date of the most recent major restructuring event. UK companies in DataStream are effectively winsorised as the earliest year available is set to 1964 in DataStream. This limitation is of minor relevance as it affects only a small proportion of companies in our sample and we control for survivorship bias by including a dummy for variable for companies present in the first year of observation (*start*).

Table 4.4 presents the descriptive statistics for the variables in this study. The denominator for firm-specific accounting variables was the average of beginning and end of year book value of assets. Unbound, continuous firm-level variables were winsorised at 0.25% unless stated otherwise. We refrain from a larger degree of winsorisation as the 0.25% level was deemed sufficient for the elimination of outliers in our sample.

Correlation coefficients are presented in Table 4.5. Despite being small in magnitude, most values are statistically significant. The strongest correlation coefficient was -0.79 between the log of firm size (*ln mva*) and the relative amount of similarly sized merger partners (*size similarity*). Both variables were treated as control variables and, therefore, we dismiss potential multicollinearity issues between the two. Most other coefficients did not exceed an absolute value of 0.30.

4.3.2 Empirical Models

In line with more recent literature on takeover likelihood, we used survival analysis to model takeover hazard (Loderer & Waelchli 2015). Specifically, we applied a version of the Cox Proportional Hazards (Cox PH) model, which was defined as:

Table 4.3: Variable definitions

Panel A: ACFCF identifiers	
Variable	Definition
d median	1 if firm-year observation is in the bottom median for Tobin's Q and in the top median of free cash flow on assets of its industry-year group, 0 otherwise. Free cash flow on assets is calculated as the difference between operating cash flows and capital expenditure divided by the average of beginning and ending year book value of assets. TQ is approximated as the sum of market value of equity and book value of debt divided by the book value of assets, where all values are taken at financial year end.
d quartile	1 if firm-year observation is in the bottom quartile for TQ and in the top quartile of free cash flow on assets of its industry year group, 0 otherwise.
d fcfoa x	1 if firm-year observation is in the top x percentile for free cash flow on assets, 0 otherwise.
Panel B: ACFCF influencers	
Variable	Definition
div on assets	Cash dividends paid divided by average of beginning- and end-of-year book values of Total Assets.
investment	CAPEX divided by average of beginning- and end-of-year book values of Total Assets.
leverage	Book value of total debt divided by book value of total assets. Winsorisation is increased to 0.50% on the right side to remove outliers.
Panel C: Control variables	
Variable	Definition
excess r	Difference between stock return and market return for the 12 months ending at financial year end. Returns are calculated on basis of DataStream's return index.
volatility	Standard deviation of monthly stock returns for the last 12 months ending at latest full month before or on financial year end.
asset utilisation	Net sales divided by average of beginning- and end-of-year book values of Total Assets.
expense ratio	Operating expense divided by Net sales. Winsorisation is increased to 2.75% on the right side for the removal of extreme values.
roa	Earnings before Interest and Taxes (EBIT) divided by average of beginning- and end-of-year book values of assets.
sales growth	Net sales divided by previous year's net sales minus one. Winsorisation is increased to 0.30% on the right side to remove extreme values.
tangible	(Property, plant and equipment minus Intangible assets) divided by book value of assets.
ln mva	Natural logarithm of (Market value of equity plus book value Total Debt).
mtb similarity	Number of companies with similar market to book ratio from the same industry-year group divided by total number of companies in the group. Similarity is assumed for all peers with market to book ratios within 0.25 standard deviations of the company in question.
size similarity	Number of similar sized companies from the same industry-year group, divided by total number of companies in the industry-year group. Similar size is assumed for companies with a market value of equity within 0.15 standard deviations of the company in question.
intensity	Number of other companies from the same industry-year group that get taken over, divided by total number of other companies in the industry-year group.
herfindahl	Sum of squared Net sales figures for all companies of the industry-year group. The top 2.5% percentile is excluded from the group to prevent misclassification (Giroud & Mueller 2010, Loderer & Waelchli 2015).
gdp growth	Year on year real GDP growth.
start	A binary variable that is 1 for all companies that are present in the first year of the panel and 0 otherwise.

Notes: This table details the calculations of variables. All firm-level variables are standardised by industry-year group. All unbound continuous variables are winsorised at the 0.25% level on each side to remove outliers, unless indicated otherwise.

Table 4.4: Descriptive statistics

	N	mean	std	min	median	max
div on assets	20 741	0.03	0.03	0.00	0.02	0.34
investment	20 741	0.06	0.07	0.00	0.04	0.65
leverage	20 741	0.19	0.18	0.00	0.16	1.52
excess r	19 116	−0.09	0.50	−2.79	−0.03	1.75
volatility	20 247	0.11	0.07	0.00	0.10	0.61
asset utilisation	20 739	1.37	0.91	0.00	1.23	6.81
expense ratio	20 259	0.99	0.55	0.35	0.93	7.02
roa	20 666	0.07	0.19	−2.95	0.09	0.69
sales growth	20 537	0.24	1.56	−1.00	0.08	33.83
tangible	20 685	0.31	0.24	0.00	0.27	0.96
mva	20 622	1062.33	4975.55	0.58	73.82	60 233.82
mtb similarity	20 622	0.20	0.11	0.00	0.21	0.50
size similarity	20 622	0.40	0.29	0.00	0.45	0.92
intensity	20 741	0.01	0.01	0.00	0.01	0.06
herfindahl	20 741	0.04	0.07	0.01	0.02	0.82
gdp growth	20 711	0.02	0.02	−0.06	0.03	0.07
d median	20 741	0.23	0.42	0.00	0.00	1.00
d quartile	20 741	0.03	0.17	0.00	0.00	1.00

Notes: This table presents descriptive statistics for the final sample from Table 4.1. Variable definitions are in Table 4.3. Market value of assets (mva) is presented in £mn.

$$h(t|1_A(x), y, 1_A(x)y, z) = h_0(t)\exp(\beta\prime 1_A(x) + \gamma\prime y + \delta\prime 1_A(x)y + \epsilon\prime z) \tag{4.1}$$

where $h(t|1_A(x), y, 1_A(x)y, z)$ is the hazard at time t conditional on vectors of covariates $1_A(x)$, y, $1_A(x)y$ and z. Also, $h_0(t)$ is the baseline hazard which, in the case of Cox PH, is non-parametric and β, γ, δ and ϵ are the vectors of coefficients to be estimated. Note that $1_A(x)$ is an indicator function that is 1 for firm-years with free cash flow agency problems or 0 otherwise; y is a vector of firm-level, fundamental variables that may amplify or ameliorate agency costs of free cash flow; z is a vector of firm-, industry- and macro-level control variables. Covariates were lagged by one period and all models incorporate firm-specific (clustered) fixed effects. We include the *start* variable in all specifications to capture possible survivorship bias for companies established before 1964.

The proportional hazards assumption states that a covariate should introduce a constant relative hazard. To test this assumption, we used generalised linear

Table 4.5: Correlation coefficients

	(1) div on assets	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(2) investment	0.07***								
(3) leverage	−0.16 ***	0.05***							
(4) excess r	0.09***	0.06***	−0.16 ***						
(5) q	0.26***	0.14***	−0.01 *	0.10***					
(6) volatility	−0.21 ***	−0.07 ***	0.14***	−0.25 ***	0.00				
(7) asset utilisation	0.13***	−0.02 ***	−0.10 ***	0.06***	0.00	−0.03 ***			
(8) expense ratio	−0.19 ***	−0.10 ***	0.08***	−0.14 ***	−0.21 ***	0.14***	0.16***		
(9) roa	0.38***	0.13***	−0.22 ***	0.31***	0.17***	−0.27 ***	0.16***	−0.46 ***	
(10) sales growth	−0.03 ***	0.10***	0.00	0.10***	0.08***	−0.02 **	0.04***	−0.06 ***	0.11***
(11) tangible	−0.06 ***	0.43***	0.17***	−0.01 *	−0.07 ***	−0.09 ***	−0.24 ***	−0.11 ***	−0.01 **
(12) ln mva	0.22***	0.09***	0.14***	0.14***	0.13***	−0.23 ***	−0.08 ***	−0.18 ***	0.24***
(13) mtb similarity	−0.18 ***	−0.05 ***	−0.10 ***	−0.03 ***	−0.48 ***	−0.04 ***	−0.13 ***	0.05***	−0.07 ***
(14) size similarity	−0.18 ***	−0.04 ***	−0.06 ***	−0.12 ***	−0.13 ***	0.17***	0.07***	0.12***	−0.16 ***
(15) intensity	0.00	0.00	−0.01	−0.04 ***	−0.01	0.00	−0.01	0.00	0.01
(16) herfindahl	0.00	0.01*	0.00	0.01	−0.01	−0.05 ***	0.04***	−0.08 ***	0.05***
(17) gdp growth	0.00	0.00	0.00	0.05***	0.00	−0.06 ***	−0.01 *	0.02**	−0.01
(18) d quartile	−0.01 *	−0.08 ***	−0.06 ***	0.03***	−0.11 ***	−0.03 ***	0.07***	−0.03 ***	0.06***
(19) d median	−0.07 ***	−0.19 ***	−0.09 ***	0.07***	−0.25 ***	−0.06 ***	0.09***	−0.03 ***	0.08***

	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
(11) tangible	−0.02 ***								
(12) ln mva	0.00	0.11***							
(13) mtb similarity	−0.05 ***	0.11***	−0.08 ***						
(14) size similarity	0.02**	−0.06 ***	−0.79 ***	0.09***					
(15) intensity	0.00	−0.01	−0.02 **	0.00	0.04***				
(16) herfindahl	0.01	0.02***	0.04***	0.01**	−0.02 ***	−0.15 ***			
(17) gdp growth	−0.01	0.00	0.00	0.00	−0.01	0.12***	−0.01		
(18) d quartile	0.01	−0.03 ***	−0.08 ***	0.05***	0.06***	0.00	0.07***	−0.01	
(19) d median	−0.01	−0.05 ***	−0.07 ***	0.19***	0.09***	0.01*	0.07***	−0.01	0.31***

Notes: The table shows Pearson correlation coefficients and an indication of their significance between all variables. Variable definitions are in Table 4.3. *p<0.1; **p<0.05; ***p<0.01.

regression of scaled Schoenfeld residuals over a function of duration (Schoenfeld 1982). Occasional violations of the proportional hazards assumption were restored by including an interaction term between duration and the violating covariate.

Furthermore, we used Accelerated Failure Time (AFT) modelling with an assumed Weibull distribution as a robustness check for the results from the Cox PH models. When using log-linear form, an AFT model can be written as:

$$\ln T = \mu - (\beta\prime 1_A(x) + \gamma\prime y + \delta\prime 1_A(x)y + \epsilon\prime z) + \sigma W \tag{4.2}$$

where $\ln T$ is the log of failure time, μ describes mean failure time and$\beta\prime 1_A(x) + \gamma\prime y + \delta\prime 1_A(x)y + \epsilon\prime z$ is the acceleration factor with variable declarations equal to Equation 4.1. Also, σW is the error term where the error term distribution is described in W, which in our case, is assumed to be Weibull.[3] The coefficients are logarithms of ratios of survival time and, as failure time is modelled, the interpretation of coefficient signs is opposite to that of a Cox PH model, because shorter survival time (AFT) implies higher risk (Cox PH) and vice versa.

A further, more simplistic model is logistic regression (logit) modelling, which is applied for robustness and comparability to older takeover likelihood literature (e.g. Palepu (1986)). Such a model can be written as

$$P(i) = \frac{1}{1 + \exp -(\beta d_x + \gamma y + \delta d_x y + \epsilon z + u_i)} \tag{4.3}$$

where, in addition to previously defined variables $P(i)$ is the probability of firm-year i receiving a successful takeover bid in the next period and u_i is the error term to the logistic regression.

[3] All models have a log(scale) coefficient close to -1, which is significantly different from zero. Therefore, the value must also be significantly different from +1, justifying the Weibull assumption over the simpler exponential distribution.

4.4 Results and Discussion

4.4.1 Takeover Likelihood and Agency Costs of Free Cash Flow

Table 4.6 lists the findings from six Cox PH interaction models over two panels, one for each viable Jensen case indicator. Each panel contains an initial model without interaction terms or controls, a model with interaction terms and a model complete with interaction terms and control variables.

The Jensen case indicator itself is only significant when using the more relaxed definition (median). However, this definition only holds until control variables are introduced. The lack of significance when using the quartile definition can be explained by the comparatively low number of events in the dummy. The only significant value in interaction terms was for dividends with the median definition (positive). Again, this significance only persists before addition of control variables. Here, it is interesting to note that the coefficient for uninteracted dividends is also significant, but has the opposite sign (negative). All control variables have the expected sign from an agency cost perspective. Higher stock price returns decrease takeover likelihood, higher financial risk, company size, the availability of merger partners, takeover intensity and economic growth increase takeover likelihood.

Our findings converge only slightly with those of Dickerson et al. (2002). The interaction dummies cannot be compared as Dickerson et al. (2002) applied interaction terms using the subtraction method. While those authors found a significant effect for CAPEX only, we find limited evidence of an effect for dividends. Our coefficients for dividends were, however, non-significant when control variables are added, which consistent with Dickerson et al. (2002). When ignoring interaction terms, the lack of significance was also reported by Palepu (1986) and Barnes (2000). Note that there is some congruence with Dickerson et al. (2002) in the missing significance for leverage. This comparison is again somewhat limited by the fact that Dickerson

Table 4.6: Interaction model with median and quartile definition

	Panel A: Median			Panel B: Quartile		
	(1)	(2)	(3)	(4)	(5)	(6)
div on assets	−0.087	−0.148**	−0.095	−0.097	−0.098	−0.064
	(0.061)	(0.071)	(0.078)	(0.061)	(0.061)	(0.069)
investment	0.034	0.045	0.074	0.122	0.121	0.116
	(0.056)	(0.058)	(0.064)	(0.115)	(0.115)	(0.124)
leverage	0.172	0.177	0.055	0.162	0.168	0.028
	(0.142)	(0.144)	(0.150)	(0.142)	(0.142)	(0.142)
d market	0.218**	0.204*	0.175	0.203	0.051	0.251
	(0.093)	(0.109)	(0.120)	(0.229)	(0.371)	(0.384)
excess r			−0.224***			−0.224***
			(0.041)			(0.040)
volatility			0.868***			0.880***
			(0.094)			(0.096)
asset utilisation			−0.026			0.027
			(0.055)			(0.055)
expense ratio			−0.084			−0.182
			(0.210)			(0.203)
roa			0.020			0.056
			(0.095)			(0.093)
sales growth			−0.090			−0.085
			(0.207)			(0.204)
tangible			0.129			0.099
			(0.099)			(0.109)
ln mva			0.125*			0.135*
			(0.075)			(0.075)
mtb similarity			0.407**			0.118
			(0.131)			(0.063)
size similarity			0.274***			0.262***
			(0.057)			(0.058)
intensity			105.219***			107.832***
			(6.492)			(6.553)
herfindahl			−0.518			6.835***
			(0.839)			(1.100)
gdp growth			13.873***			13.553***
			(2.718)			(2.707)
div on assets:d market		0.278**	0.111		0.008	0.036
		(0.132)	(0.153)		(0.380)	(0.408)
investment:d market		−0.122	−0.127		−0.018	0.408
		(0.204)	(0.211)		(0.604)	(0.628)
leverage:d market		−0.054	−0.047		−0.501	−0.371
		(0.184)	(0.183)		(0.625)	(0.573)
start	−2.621***	−2.630***	−1.954***	−2.628***	−2.631***	−1.847***
	(0.125)	(0.125)	(0.156)	(0.125)	(0.125)	(0.157)
d market		d median			d quartile	
Observations	20 741	20 741	18 514	20 741	20 741	18 514
Number of events	594	594	548	594	594	548
Number of events in d market	170	170	160	20	20	19
R^2	0.026	0.026	0.054	0.026	0.026	0.056
Max. Possible R^2	0.399	0.399	0.406	0.399	0.399	0.406
Log Likelihood	-5004.369	-5002.137	-4304.549	-5006.120	-5005.791	-4289.246
Wald Test	400.210***	404.150***	1195.880***	399.040***	403.410***	1176.430***
LR Test	550.894***	555.358***	1034.580***	547.393***	548.050***	1065.187***
Score (Logrank) Test	642.893***	646.178***	1274.378***	639.304***	639.809***	1261.852***

Notes: This table presents a test for a disciplining effect from takeover markets for high free cash flow and low Tobin's Q firms using Cox PH models. Panel A identifies candidates for disciplinary action on the basis of Tobin's Q below the industry-year wise median and free cash flow on assets above the industry-year wise quartile. Panel B repeats the test on the basis of a quartile definition. For each panel, we first display a model without controls and without interaction terms, and then a model with interaction terms and finally, a model with interaction terms and controls. Models in Panel A contain interaction terms between duration with leverage, volatility, sales growth, tangible, mtb similarity and intensity. Panel B models contain duration interaction terms with volatility and tangible. These interaction terms protect the Cox PH assumption. Standard errors are provided in parentheses. See Table 4.3 for detailed definitions of all variables. *p<0.1; **p<0.05; ***p<0.01.

et al. (2002) did not interact leverage with the agency cost indicator. Similarly, the missing significance for leverage matches that of Powell & Yawson (2007) and Loderer & Waelchli (2015).

Differences to Dickerson et al. (2002) may be due to differences in the sample (both are from the UK, but time periods are shifted by roughly ten years). This is most likely the case for CAPEX since Dickerson et al. (2002) found significance both in and out of the interaction dummy, while our results were non-significant both in and out of the interaction term. It is more likely, however, that interaction term differences are due to the inclusion of the free cash flow component in the dummy specification.

Importantly, our results challenge the validity of the ACFCF identifier used in Dickerson et al. (2002). The median definition applied in that study implies that half of the sample always suffers from ACFCF. Our slightly more refined approach demonstrates only limited evidence for a disciplining effect on free cash flow problems through takeover markets. Assuming our combined definitions hold, firms' ACFCF were handled through other corporate governance mechanisms than the threat of takeover.

Two additional tests provided further analysis and validation of our results. The following section examines the effect of high free cash flows, ignoring the effect of TQ.[4] Also, an alternative method of modelling takeover likelihood serves as a robustness test of the results provided in Table 4.6.

4.4.2 The Impact of High Free Cash Flows

The previous analysis lead to further investigation of the impact of high free cash flows on takeover risk. Table 4.7 repeats the final specification from Table 4.6 (models 3 and 6) but replaces the interaction dummy with an identifier of high free cash

[4]An examination of the impact of high takeover intensity on our values in Table 4.6 did not lead to conclusive results.

flows. We began with a strict definition of free cash flows in the top decile (model 1), which was gradually extended across another four models and ending with a top 40% cut-off in model 5.[5]

The dividend interaction term was significant negative in models 2 to 4, while the level of investment was significant negative in models 1, 4 and 5. Note that the high free cash flow dummy and interacted leverage were not significant in any model. These findings indicate that, when free cash flows are high, a company can decrease its takeover risk by expending the generated money (i.e., decrease cash hoarding) either by increasing CAPEX or a payout to investors, which is reasonable because the dummy ignores TQ. In connection with these variables, a further potentially informative indicator of payout to investors might be net interest expense instead of the level of leverage. This does not mean by inversion of the argument that hoarding the money leads to increased takeover likelihood since the dummy variables were always non-significant. It was not possible to perform an analysis of cash holding due to missing data.[6]

4.4.3 Robustness Check

Accelerated Failure Time Modelling

In Table 4.8, we repeat all models from Table 4.6 with accelerated failure time models. The results for key variables appear to be robust. Specifically, the identifier of ACFCF significantly decreases survival time in models 1 and 2, similar to the increase in risk for the same variable in Table 4.6. The only significant interaction term was on dividends in model 2. The sign for the coefficient was, again, opposite to that in Table 4.6. Also, the only significant interaction term was on dividends for model 2 (negative) with the standalone dividend coefficient being significant and of

[5] By industry-year group

[6] DataStream holds three alternative variables for the amount of cash on a company's balance sheet. All three failed to deliver an amount of observations in line with data availability for all other variables. We were not able to detect a pattern in the missingness, e.g. not only small companies were affected. Accordingly we classified the missingness an issue of data quality and removed the variable from all samples.

Table 4.7: Analysis of the impact of high free cash flow

	(1)	(2)	(3)	(4)	(5)
div on assets	−0.019	0.002	0.022	0.051	−0.005
	(0.075)	(0.078)	(0.080)	(0.084)	(0.102)
investment	0.159	0.167	0.170	0.181	0.191
	(0.122)	(0.122)	(0.121)	(0.119)	(0.118)
leverage	0.056	0.074	0.091	0.077	0.063
	(0.078)	(0.079)	(0.081)	(0.085)	(0.089)
d market	−0.147	0.076	0.017	−0.036	0.022
	(0.237)	(0.171)	(0.147)	(0.124)	(0.112)
excess r	−0.224***	−0.228***	−0.227***	−0.229***	−0.233***
	(0.041)	(0.041)	(0.041)	(0.041)	(0.041)
volatility	0.886***	0.874***	0.877***	0.880***	0.877***
	(0.095)	(0.095)	(0.095)	(0.095)	(0.095)
asset utilisation	0.041	0.038	0.040	0.049	0.049
	(0.055)	(0.055)	(0.055)	(0.055)	(0.055)
expense ratio	−0.175	−0.161	−0.157	−0.144	−0.153
	(0.205)	(0.205)	(0.205)	(0.205)	(0.205)
roa	0.048	0.021	0.024	0.026	0.014
	(0.098)	(0.096)	(0.097)	(0.098)	(0.097)
sales growth	−0.072	−0.073	−0.074	−0.081	−0.074
	(0.200)	(0.201)	(0.203)	(0.205)	(0.205)
tangible	0.067	0.075	0.078	0.092	0.091
	(0.108)	(0.107)	(0.107)	(0.107)	(0.107)
ln mva	0.134*	0.136*	0.134*	0.132*	0.134*
	(0.075)	(0.075)	(0.075)	(0.075)	(0.075)
mtb similarity	0.413**	0.421**	0.418**	0.406**	0.408**
	(0.128)	(0.128)	(0.127)	(0.127)	(0.127)
size similarity	0.267***	0.265***	0.264***	0.264***	0.267***
	(0.058)	(0.058)	(0.058)	(0.058)	(0.058)
intensity	107.225***	106.983***	106.491***	106.586***	107.423***
	(6.609)	(6.590)	(6.589)	(6.607)	(6.616)
herfindahl	6.670***	6.637***	6.679***	6.714***	6.741***
	(1.102)	(1.099)	(1.098)	(1.097)	(1.096)
gdp growth	13.507***	13.530***	13.541***	13.433***	13.359***
	(2.703)	(2.701)	(2.702)	(2.698)	(2.701)
div on assets:d market	−0.237	−0.286**	−0.292**	−0.291**	−0.117
	(0.181)	(0.156)	(0.147)	(0.136)	(0.133)
investment:d market	−0.671*	−0.402	−0.379	−0.513**	−0.449**
	(0.407)	(0.289)	(0.248)	(0.207)	(0.174)
leverage:d market	0.304	0.071	−0.057	0.012	0.034
	(0.237)	(0.209)	(0.190)	(0.162)	(0.148)
start	−1.840***	−1.845***	−1.847***	−1.841***	−1.839***
	(0.157)	(0.157)	(0.156)	(0.156)	(0.157)
d market	d fcfoa 10	d fcfoa 15	d fcfoa 20	d fcfoa 30	d fcfoa 40
Observations	18 514	18 514	18 514	18 514	18 514
Number of events	548	548	548	548	548
Number of events in d market	36	70	100	166	235
R^2	0.057	0.057	0.057	0.057	0.057
Max. Possible R^2	0.406	0.406	0.406	0.406	0.406
Log Likelihood	-4281.954	-4282.333	-4281.992	-4279.139	-4280.901
Wald Test	1195.730***	1179.630***	1188.690***	1194.180***	1194.880***
LR Test	1079.770***	1079.013***	1079.694***	1085.401***	1081.876***
Score (Logrank) Test	1276.077***	1274.755***	1274.371***	1278.827***	1276.327***

Notes: This table presents Cox PH models for testing the impact of high free cash flow with respect to influencers of agency costs of free cash flows on takeover likelihood without consideration of Tobin's Q using Cox PH models. The free cash flow on assets dummy is first defined at the top decile (Model 1), which is then progressively relaxed until the top 40% in Model 5. All models include interaction terms and control variables. Models contain interaction terms of volatility, investment, sales growth, tangible, mtb similarity, intensity, and herfindahl with duration. These interaction terms are for the protection of the proportional hazards assumption. Standard errors are provided in parentheses. See Table 4.3 for detailed definitions of all variables. *p<0.1; **p<0.05; ***p<0.01.

the opposite sign. Contrary to Cox PH models, all AFT models returned a significant decrease of survival time on higher leverage outside the interaction dummy before controls were added.

Control variables partially differed in significances. Market value of assets was not significant, as illustrated in Table 4.8, when there was a significant positive effect in the Cox equivalent. Significance on *mtb similarity* in model 3 and *herfindahl* in model 6 from Table 4.6 was lost when using AFT. Note that the models concur on excess return, intensity and GDP growth.

Logistic Regression Modelling

For additional robustness the main results were also modelled using logistic regression (logit) in Table 4.9. The interpretation of signs from a logit model is similar to that of a Cox PH model in that a positive sign is indicative of a positive relation of the coefficient with takeover risk and vice versa in case of a negative sign. The table set up is similar to Table 4.6 and Table 4.8. d market in the median definition was now always significant positive, while significance dissipated with Cox PH modelling. The only concurrence in interaction term significance was dividends with the median dummy definition for ACFCF. Just as in Cox PH modelling, the sign of this interaction term was wrong for agency costs of free cash flow. Leverage, outwith the interaction terms, was now occasionally significant positive, which is also the wrong sign for agency costs. Logit is generally inferior to Cox PH modelling and probably overstated the significance levels of the median-defined d market. With the exception of the median dummy, logistic regression modelling did not find a disciplining effect through the threat of takeover on agency costs of free cash flow, so that the main result was largely supported by this robustness test.

Table 4.8: Accelerated failure time modelling

	Panel A: Median			Panel B: Quartile		
	(1)	(2)	(3)	(4)	(5)	(6)
div on assets	0.026	0.050*	0.015	0.031	0.031	0.009
	(0.025)	(0.028)	(0.023)	(0.025)	(0.026)	(0.022)
investment	−0.018	−0.022	−0.027	−0.011	−0.011	−0.017
	(0.025)	(0.025)	(0.024)	(0.025)	(0.025)	(0.024)
leverage	−0.053*	−0.058*	−0.029	−0.048*	−0.050*	−0.025
	(0.029)	(0.030)	(0.031)	(0.028)	(0.029)	(0.029)
d market	−0.087**	−0.082*	−0.057	−0.097	−0.049	−0.100
	(0.038)	(0.046)	(0.044)	(0.093)	(0.129)	(0.120)
excess r			0.080***			0.079***
			(0.013)			(0.013)
volatility			0.018			0.020
			(0.022)			(0.022)
asset utilisation			−0.005			−0.006
			(0.023)			(0.022)
expense ratio			0.011			0.014
			(0.090)			(0.089)
roa			0.001			−0.002
			(0.033)			(0.032)
sales growth			0.050			0.050
			(0.046)			(0.045)
tangible			−0.001			0.0002
			(0.022)			(0.022)
ln mva			−0.027			−0.026
			(0.028)			(0.028)
mtb similarity			−0.021			−0.027
			(0.027)			(0.027)
size similarity			−0.076***			−0.079***
			(0.021)			(0.021)
intensity			−12.035 ***			−12.160 ***
			(1.083)			(1.070)
herfindahl			−0.109			−0.156
			(0.336)			(0.328)
gdp growth			−5.628***			−5.652***
			(0.926)			(0.933)
div on assets:d market		−0.103**	−0.032		−0.016	0.001
		(0.045)	(0.046)		(0.115)	(0.124)
investment:d market		0.040	0.040		0.012	−0.147
		(0.091)	(0.085)		(0.258)	(0.236)
leverage:d market		0.029	0.027		0.152	0.085
		(0.080)	(0.068)		(0.200)	(0.177)
start	0.974***	0.976***	0.972***	0.976***	0.977***	0.972***
	(0.041)	(0.041)	(0.038)	(0.041)	(0.041)	(0.038)
Constant	3.790***	3.787***	3.954***	3.769***	3.768***	3.941***
	(0.043)	(0.043)	(0.059)	(0.042)	(0.042)	(0.059)
d market		d median			d quartile	
Observations	20 741	20 741	18 514	20 741	20 741	18 514
Number of events	594	594	548	594	594	548
Number of events in d market	170	170	160	20	20	19
Scale	0.377	0.376	0.338	0.377	0.377	0.338
Log(Scale)	-0.975***	-0.977***	-1.085***	-0.975***	-0.976***	-1.085***
Log Likelihood	-3969.040	-3966.706	-3534.444	-3971.418	-3971.180	-3536.256
χ^2	629.195***	633.865***	831.253***	624.441***	624.916***	827.630***

This table details a robustness check for the results presented in Table 4.6 using accelerated failure time models. All models assume a Weibull distribution of the error term. All models have a log(scale) coefficient close to -1, which is significantly different from zero. Therefore, the value must also be significantly different from +1, justifying the Weibull assumption over the simpler exponential distribution. See Table 4.3 for detailed definitions of all variables. *p<0.1; **p<0.05; ***p<0.01. Standard errors are provided in parentheses.

Table 4.9: Logistic regression modelling

	Panel A: Median			Panel B: Quartile		
	(1)	(2)	(3)	(4)	(5)	(6)
div on assets	−0.026	−0.071	−0.083	−0.037	−0.037	−0.055
	(0.054)	(0.061)	(0.074)	(0.053)	(0.054)	(0.066)
investment	−0.031	−0.044	−0.030	−0.059	−0.062	−0.065
	(0.052)	(0.055)	(0.065)	(0.051)	(0.052)	(0.063)
leverage	0.119**	0.108	0.023	0.101*	0.103*	0.025
	(0.060)	(0.065)	(0.078)	(0.059)	(0.060)	(0.072)
d market	0.319***	0.376***	0.348***	0.198	0.282	0.476
	(0.095)	(0.106)	(0.117)	(0.233)	(0.347)	(0.354)
start	−0.011	−0.012	−0.054	−0.013	−0.013	−0.056
	(0.084)	(0.084)	(0.091)	(0.084)	(0.084)	(0.091)
excess r			−0.169***			−0.164***
			(0.040)			(0.040)
volatility			0.114**			0.107*
			(0.057)			(0.057)
asset utilisation			0.059			0.071
			(0.053)			(0.052)
expense ratio			−0.108			−0.109
			(0.152)			(0.150)
roa			0.053			0.066
			(0.090)			(0.090)
sales growth			−0.297***			−0.296***
			(0.104)			(0.103)
tangible			0.071			0.077
			(0.052)			(0.052)
ln mva			0.227***			0.234***
			(0.077)			(0.077)
mtb similarity			0.161***			0.194***
			(0.062)			(0.062)
size similarity			0.145**			0.157***
			(0.059)			(0.059)
intensity			29.550***			29.801***
			(3.644)			(3.633)
herfindahl			−0.934			−0.758
			(0.741)			(0.728)
gdp growth			8.757***			8.696***
			(2.509)			(2.510)
div on assets:d market		0.237*	0.178		−0.033	−0.010
		(0.130)	(0.144)		(0.351)	(0.387)
investment:d market		0.115	0.029		0.333	0.542
		(0.172)	(0.191)		(0.525)	(0.547)
leverage:d market		0.059	0.012		−0.135	−0.202
		(0.167)	(0.178)		(0.497)	(0.489)
Constant	−3.596***	−3.596***	−4.334***	−3.522***	−3.522***	−4.270***
	(0.064)	(0.064)	(0.125)	(0.058)	(0.058)	(0.123)
d market		d median			d quartile	
N	20 741	20 741	18 514	20 741	20 741	18 514
Number of events	594	594	548	594	594	548
Number of events in d market	170	170	160	20	20	19
Log Likelihood	-2687.906	-2685.995	-2383.919	-2692.974	-2692.734	-2388.088
Akaike Inf. Crit.	5387.812	5389.990	4811.838	5397.948	5403.468	4820.176

This table details a robustness check for the results presented in Table 4.6 using logistic regression (logit) models. See Table 4.3 for detailed definitions of all variables. *p<0.1; **p<0.05; ***p<0.01. Standard errors are provided in parentheses.

4.4.4 Discussion

The results provided in Table 4.7 adds to criticism of Dickerson et al. (2002) by underlining the importance of high free cash flows when testing for the effects of ACFCF in takeover markets. The results for the interacted variables for investment and dividends provide strong support for Jensen (1986). The missing significance for the interaction term for leverage might be restored if interest expense is examined rather than the level of debt. We use leverage for consistency with previous studies, not only in Dickerson et al. (2002), but the takeover likelihood literature more generally (for example Powell & Yawson 2007. Additionally, Jensen (1986) identifies signals of a permanent increase in payout to shareholders, which is more accurately indicated by leverage than interest expense.[7]

The disparity to results in Dickerson et al. (2002) is not driven by their lack of accounting for free cash flow alone. As visible in Table 3.10 from Chapter 3, the response from agency cost indicators towards likelihood of disciplinary takeover are getting weaker when relaxing the TQ threshold.[8] However, this does not explain why we do not find comparable results to Dickerson et al. (2002).

There are a number of possible reasons for this, of which sampling issues will be most influential. In particular, the time periods covered in the respective studies are covering different economic regimes (1976 to 1990 vs. 1986 to 2015). The main reason for using a more recent sample than in the Dickerson study is that the 70s and 80s, Thatcher era is hardly representative for inference today. Most notably the 70s and 80s are covering phases from pre-globalised world to globalisation with heavy privatisation efforts and transformation of the UK economy from manufacturing to services in the UK (Hall 1993, May 1996, Thompson 2014). Another influencing factor would have been the oil crises of the 70s (Campbell 2005). The 1990s and early 2000s, by comparison, were marked by the advent of the internet and increased global competition (Shiller 2015), as well as the expansion of the Chinese economy

[7] Jensen (1986) rejects the use of share buybacks to decrease ACFCF for this reason.

[8] This is confirmed by running two models with close resemblance to those in Dickerson et al. (2002). See Table C.1 in the Appendix.

(Barro 2016) and the global financial crisis, which was the largest since the 1929 crash (Ivashina & Scharfstein 2010). These differences are visible in ratios of takeover to total firms of 36% in Dickerson et al. (2002) compared to 28.64% in our case.

The calculation of variables is congruent insofar that flow variables were scaled by average assets, not end of year total assets. A difference, however, is that Dickerson et al. (2002) use net assets and we use total assets for scaling. Because leverage is traditionally low in UK companies (median debt on assets of 16% in our sample, see Table 4.4) this effect will be negligible. A notable exception to this is the calculation of TQ. While we are following the approach of approximating TQ as market value of assets over book value of assets, Dickerson et al. (2002) use the more elaborate TQ proxy from Lindenberg & Ross (1981). Chung & Pruitt (1994) show that there is a 96% alignment between the two methods, so that the effect will be negligible in our sample and not sufficient for explaining the differences in findings.

Finally, one must keep in mind that results in Dickerson et al. (2002) are not conclusive with regards to agency costs of free cash flow. Increases in CAPEX were decreasing takeover likelihood both within and out of the low TQ interaction, which contradicts agency theory. Dividends were not significant at all, also not matching the hypothesis based on Jensen (1986). In summary, whatever effect Dickerson et al. (2002) found, does not seem to exist anymore. The bottom median is not a sufficient cutoff (see Table C.1 in the Appendix and the TQ definition test in Table 3.10 in Chapter 3) and ignoring FCF is misleading in terms of economic theory and empirical results (see Table 4.6 and Table 4.7 in this chapter).

4.5 Conclusions

This study assesses the threat of takeover as a tool for disciplining companies with agency costs of free cash flows. We aimed to answer the following two questions: (1) Can we identify companies with free cash flow agency problems? and (2) If yes, are such companies disciplined in takeover markets? Indeed, we could identify a set of company-year observations where high free cash flows were generated, but growth opportunities for investment of that cash were lacking by requiring both TQ to exceed and free cash flow on assets to fall below industry-year-wise cut-offs. However, we only found limited evidence for such companies being disciplined in takeover markets. We did not observe strong evidence for companies' ability to reduce takeover likelihood by distributing cash to investors. These two findings were established by using our ACFCF identifiers as interaction terms with variables of cash disgorgement in models of takeover likelihood. These findings strongly indicate that agency costs of free cash flow are regulated through means other than the market for corporate control.

Alternatively, it might be possible that high free cash flow companies are repeatedly taken over before TQ can sink too far. Our examination of the effect of free cash flow interaction terms (without TQ) does not provide evidence for higher takeover risk in high free cash flow companies. Such companies can, however, decrease their likelihood of becoming a target by expending or distributing cash.

We provide key contributions to the literature by further developing a method for identifying ACFCF. We are further able to demonstrate that ACFCF have only a limited role in takeover markets. Subsequent research might seek to establish how alternative corporate governance mechanisms affect ACFCF in the takeover market and with respect to general corporate valuation.

Chapter 5

Conclusion

This chapter presents concluding remarks in the form of summary findings and their contributions to the literature, implications and limitations and derives avenues for future research.

5.1 Summary of the Main Findings

In this thesis, we provide evidence for agency costs in UK takeover markets through the study of bidding firm abnormal returns and an examination of takeover likelihood. This thesis adopts a framework where negative bidding firm abnormal returns are a result of agency costs. Chapter 2 of the thesis reassesses the magnitude of such costs by refining the underlying methodology for abnormal return calculation. Similarly, in the framework adopted in this thesis and in the context of the market for corporate control, a company's likelihood of becoming a takeover target is driven by its agency costs. In Chapter 3 of this study a large range of agency cost proxies is applied to reclassify a set of disciplinary targets. Both, agency cost indicators and disciplinary target definitions, are combined to predict takeover likelihood, which allows to reassess the functioning of the market for corporate control. A final empirical chapter employs a narrower set of indicators to assess the effects of agency costs of free cash flow on takeover likelihood.

In Chapter 2, we refine the methodology for assessing bidding firm abnormal returns, that serve as a demonstration of the price finding mechanism as the driver of the market for corporate control. The following questions are investigated: (1) Are there ARCH effects when conducting M&A event studies in the UK? (2) Can models from the GARCH family help ameliorate the estimation problems of OLS when ARCH effects are present? (3) Are the resulting abnormal returns different from standard event studies when using ARCH models? and (4) Do these differences translate to variations in Cumulative Abnormal Return (CAR) cross-sectional models? ARCH effects are detected in about half of events. We correct the usual OLS estimator for Autoregressive Conditional Heteroscedasticity (ARCH) effects, where appropriate, by applying a range of Generalised ARCH (GARCH) type models, which is effective in all but 4% of events. We report significantly greater CAR for both short- and long-term event windows, without repudiation of the traditional finding of long-term value destruction for bidding firms.

The central mechanism for resolving agency costs in takeover markets is the market for corporate control, which we examine through the lens of takeover likelihood in Chapter 3. The issue is approached by asking (1) How effective is the market for corporate control in an economy with an open merger policy? and (2) What agency cost indicators are associated with market discipline? We identified sets of disciplinary candidates that experience a significantly increased likelihood of becoming a takeover target when using excess return to define the set. Here, firm fundamental agency indicators had a minimal effect. In contrast, defining the set through Tobin's Q (TQ) leads to changes in takeover likelihood depending on firm fundamentals associated with agency costs. In particular, firms with higher sales growth and asset utilisation within the low TQ set experienced higher takeover likelihood and firms with higher profitability within the same set had lower takeover risk. Comparing this evidence from our UK sample, in which anti-takeover provisions are prohibited, to findings from US studies, raises support for the potency of an open merger policy if policy makers intent to establish a functional market for corporate control.

In a third empirical chapter, the driving research questions are: (1) Can we identify companies with free cash flow agency problems? and (2) If yes, are such companies disciplined in takeover markets? We identified a set of disciplinary candidates by using high free cash flow on assets in combination with low TQ for the definition of the disciplinary set. With this method, there was no robust evidence for the relevance of agency costs of free cash flow in the market for corporate control. However, we demonstrated that high free cash flow should not be omitted when testing the role of agency costs of free cash flow in the market for corporate control as we did find possibilities for lowering takeover likelihood by expending or distributing cash for high free cash flow firms.

This research provides contributions to the literature on Mergers and Acquisitions (M&A) and agency costs by (1) presenting an update on the value creation in UK bidding firms by methodological refinement, and (2) refining previous attempts to define disciplinary candidates in takeover likelihood studies and thereby identifying a detailed view of the mechanism underlying the market for corporate control with regards to agency costs and agency costs of free cash flow. We presented evidence for a functional market for corporate control reflected in higher takeover likelihood for low TQ firms with firm fundamentals indicating agency costs. Additionally, we observed higher takeover likelihood for a set of firms that experience falls in stock price, but this set has little relation to agency costs. Finally, the market for corporate control is not activated for reducing agency costs of free cash flow.

5.2 Implications of the Study

The findings presented in this thesis present a set of implications for (1) researchers regarding agency costs, corporate governance mechanisms and M&A, (2) practitioners such as analysts, shareholders and management as well as market observers, and finally (3) regulators and policymakers.

When researchers conduct M&A event studies, ARCH effects have a significant impact because OLS overstates systemic risk of bidders in the presence of ARCH problems. The result is a higher benchmark return, which leads to significantly lower CARs. Our evidence suggests that previous studies have overstated the magnitude of value destruction for M&As in the UK and should be downward corrected. Cross-sectional studies of bidding firm CARs remain valid as there were no significant differences in coefficients found from such regressions. Considering takeover likelihood, the most important implication for researchers examining the market for corporate control is that the cut-off point for excess return and TQ must be set relatively low for the classification of the disciplinary set. Most takeovers are not disciplinary in this study. Notably, when using TQ, the median is not sufficient as we observe the most significance of agency indicators the lowest 10% to 20% TQ sets with diminishing significance towards the 40% cut-off. For market for corporate control studies focussing on agency costs of free cash flow, it is not sufficient, as in Dickerson, Gibson & Tsakalotos (2002), to define disciplinary takeovers using Tobin's Q alone without consideration of the magnitude of free cash flows. Finally, researchers can expect markedly different results in economies with weaker shareholder protection.

For practitioners, our results regarding bidding firm abnormal returns demonstrate that the previous finding of long-term underperformance must be somewhat upwardly revised. Importantly, shareholder value is still destroyed, meaning UK acquisitions do not serve owners and are, therefore, on average, agency costs. Shareholders should be cautious of their management's acquisition plans. Management can draw on our results and consider what abnormal return drivers can help them perform better than their peers and possibly circumvent disciplinary takeovers.

Through the study of takeover likelihood, we observe a well-functioning market for corporate control in the UK. The market for corporate control does not simply act as a disciplinary mechanism but also puts pressure on managers to act in the best interests of shareholders. Our indicators provide direct evidence of this pressure. The significance of explanatory variables in takeover likelihoods models suggests that algorithmic trading could be profitable, but further testing is recommended. For example, our Accelerated Failure Time (AFT) models can forecast the number of years before a company becomes a takeover target. However, what is important for practitioners is that we are able to demonstrate which companies are likely to be disciplinary candidates. In our sample, takeover likelihood for disciplinary candidates can be inferred from analysis of the ratio of Tobin's Q to asset utilisation, sales growth and profitability. Furthermore, a sharp drop in a company's share price during the preceding 12 months invites takeover irrespective of firm fundamental agency cost proxies. We did not find evidence that agency costs of free cash flow are an effective indicator of disciplinary takeover likelihood. Rather, the results reveal that ignoring free cash flow generation in studying agency costs of free cash flow results in spurious results. There is evidence for the hypothesis that companies with high free cash flows might be taken even at higher levels of Tobin's Q. An additional implication is that companies with high free cash flows do not experience elevated takeover hazard per se but can decrease their likelihood of becoming a target by distributing cash.

For regulators, the main implication is that an open merger policy is desirable if a functional market for corporate control is supposed to protect shareholders from agency costs. The point is made especially clear when comparing our takeover likelihood results to US-based research where anti-takeover provisions are allowed and widely applied to the benefit of the target firm's management. On this basis, a follow-up study could examine whether agency costs exhibit similar predictive power for US companies, where anti-takeover provisions are commonly allowed.

5.3 Limitations

The results and their implications in this thesis must be considered under the following possible limitations in assumptions, data and methodology, as well as interpretation.

In this thesis, Tobin's Q is approximated by sum of market value of equity and book value of debt divided by book value of total assets. This proxy has been shown to converge with a more precise estimate that is conceptionally closer to the original ratio of market value of assets to replacement costs of assets developed by Lindenberg & Ross (1981). According to Chung & Pruitt (1994), the approximate TQ values explain 96.6% of the theoretically correct values. Given the importance of TQ for our results, the variation between the two measures offers an opportunity for further investigation. The value of Tobin's Q used in this study (and in most other research; see Coles, Daniel & Naveen 2008, McKnight & Weir 2009, Danbolt, Siganos & Tunyi 2016, Dargenidou, Gregory & Hua 2016) is conceptionally closer to that of an unlevered market to book ratio (Penman 2013).

An ideological limitation of the thesis is that the topic of agency costs is tightly integrated with a theory of the firm that assigns primacy to shareholder value maximisation (Jensen 2001, Schwartz 2017). The implications for policymakers derived from our findings are provided in the same spirit, and practitioners pursuing a more balanced stakeholder approach should consider this issue.

As demonstrated by the introductory example of ABN Amro and RBS (see Chapter 1), the market for corporate control may not be effective in disciplining exceptionally large targets. Similarly, in some situations bidders may lack financial resources or be unwilling to rescue distressed companies. There may also be broader situations of elevated uncertainty, such as financial crises. In this thesis, measures of firm size, takeover intensity, economic growth, and industry-year effects are included to account for the effects of crises and size. Despite the use of these controls further investigation of these particular situations could be undertaken.

A point that usually receives minimal attention in M&A event studies is that small bidders might react in a more volatile manner to takeover announcements, which could lead to an over- or understatement of average abnormal returns (see for example Fama & French 1993). From a market-wide perspective it might be informative to examine value weighted average abnormal returns.

Most takeover likelihood models presented in this thesis rely on Cox Proportional Hazards (Cox PH) modelling which, as the name suggests, assumes the hazard introduced by a variable to be constant across the duration of a subject. The assumption is somewhat questionable from an economic perspective as older firms might behave differently than younger firms and, indeed, the proportional hazards assumption was violated multiple times in our models. We countered this violation by introducing interaction terms with duration for the variables in question. Additionally, we added parametric tests as well as logistic modelling for robustness, which confirmed our findings.

A limitation to our findings on the role of ARCH effects is that 3.96% of events had a significant ARCH-LM test for all attempted models. A possible allay for future research is to apply more elaborated GARCH-type models to remove the remaining ARCH effects. Additionally, one might argue that it is sufficient to correct ARCH effects using Heteroscedasticity and Autocorrelation Consistent (HAC) standard errors and thereby not change the OLS estimators (Newey & West 1987). Importantly, the very purpose of Chapter 2 is studying the impact of GARCH correction on event study methodology for bidding firm abnormal returns to M&A announcements so that HAC is of little relevance.

Additionally, most variables in takeover likelihood models are scaled by the average of the beginning and end of year assets. While this approach is not entirely uncommon in academia, the standard seems to be to scale by end of year values. We have given precedence to our method due to its use by practitioners and, in our opinion, greater intuitive sense.[1, 2]

Finally, the sample in this thesis is collected from the pre-Brexit era. Depending on the ultimate nature of Brexit and the subsequent reaction of market participants, some of our results might be vastly different to a future UK sample. So far, deal value has increased domestically for UK companies in an attempt to prepare for the

[1] See e.g. Penman 2013

[2] A year's profit is earned by using the assets over the year. Assets at the end of the year are a result of assets at the start of year plus earnings and changes to capitalisation.

regulatory effects of Brexit (Cristerna et al. 2018). The more questionable aspect from this thesis, after Brexit, is probably abnormal return creation, both short and long term. The functioning of the market for corporate control is not likely to be impeded by Brexit as the open merger policy is likely to continue. That said, a change in takeover appetite might lead to different results, even though this is unlikely as we have controlled for takeover intensity in our results.

5.4 Directions for Future Research

The methodology described in Chapter 2 can be applied to other countries for a study of targets or combined firms, or issues different from M&A announcements. As previously discussed, small events might be overrepresented in the simple mean calculation. A way to prevent the near omission of small events, such as a value-weighted average produces, might be the reporting of results for events sorted by deciles according to bidder size, deal size or a ratio of the two. Important for the relevance of an open-merger regime, the connection between agency costs and long-term bidder abnormal returns should be analysed in economies that allow anti-takeover provisions. The problem of remaining ARCH effects in our study (see Section 5.3) can be resolved in future studies by applying more elaborate GARCH models, compared to those used in Chapter 2. Additionally, in our sample, events with ARCH problems seem to have more negative returns than events without ARCH effects. As such, it would be interesting to examine if ARCH effects can serve as an indicator of negative returns, both in the context of M&A and outwith. This study could be complemented by an analysis of firm characteristics of ARCH-problematic firms compared with those of other firms.

Future research on takeover likelihood and the market for corporate control could also apply our methodology for classifying and analysing disciplinary candidates in other markets, especially the US. Results from such a study can be expected to be especially meaningful for policymakers. Furthermore, a separate study might seek to establish if a voluntary abolishment of anti-takeover provisions for a firm in which such tactics are allowed acts as an effective bonding mechanism (the signal to shareholders is a decrease in agency costs). The limits of the market for corporate control can be studied by defining cases where the takeover mechanism fails to prevent bankruptcy or state intervention, such as with very large targets, missing financial power or willingness to takeover of other market participants as well as situations of increased economy-wide uncertainty. Our results regarding agency costs of free cash flow suggest an examination of alternative corporate governance systems is warranted. Such a study would seek to identifying which regime is most effective at managing this specialised form of agency cost. Initially, the methodologies for the disciplinary set construction in Chapters 3 and 4 can be applied to a panel investigation in the tradition of McKnight & Weir (2009).

Finally, Brexit is likely to have an impact on M&A markets, deal structuring, target choice and investment levels. Statistically, Brexit should be treated as a regime change. Accordingly, it might be worth repeating our abnormal return and takeover likelihood studies during the coming years when sufficient post-Brexit data are available. Regardless, it will be interesting to observe how shareholders assess bid announcements in a post-Brexit era.

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Appendix A

Supporting Evidence to Chapter 2

Table A.1: Variable definitions

Variable	Definition
Panel A: Deal Characteristics	
ex post-takeover count	The total number of acquisitions per acquirer during our period of observation
event date	The announcement date of an acquisition
deal value	The value of the acquisition in million British Pound (2015)
market Cap	The market value of the acquirer's equity on the acquisition date in million British Pound (2015)
rel deal value	Ratio of deal value to acquirer market cap
same industry	A dummy that is 1 when the acquirer and target have the same 4-digit SIC code
pct acquired	The percentage of the target's equity acquired
mtb similarity	The amount of industry participants with a market-to-book ratio within 0.25 standard deviations of the acquirer divided by total number of industry participants for a year
size similarity	The number of industry participants with a market value of equity within 0.15 standard deviations of the acquirer divided by total number of industry participants for a year
Panel B: Agency cost proxies	
q	The sum of market value of equity at event date and book value of debt divided by book value of assets
roa	Earnings before Interest and Taxes (EBIT) divided by average assets
sales growth	Year-on-year change in net sales
leverage	End of year total debt divided by end of year book value of assets
mva	Market value of equity at event date plus book value of debt in million British pounds (2015)
asset utilisation	Net sales divided by average assets
expense ratio	Operating expenses over net sales
div on assets	Dividends paid divided by average assets
investment	Capital Expenditure (CAPEX) over average assets
tangible	Property, Plant and Equipment (PPE) divided by end of year assets
Panel C: Environmental factors	
intensity	Industry-year wise number of acquisitions divided by the number of industry members
herfindahl	Industry-year wise sum of squared market shares where the top 2.5 percentile is excluded
gdp growth	Year-on-year change in real Gross Domestic Product (GDP) for the UK

Notes: The table details the calculation of variables used in cross-sectional modelling and subsequent coefficient difference testing. Average assets are calculated as the average of beginning and end of year book value of assets.

Table A.2: Comparison of regression models

Panel A: Long term models (CAR t_3 to t_{520})

	All events						Corrected events only					
	IM	MM	IM	GAM	MM	GAM	IM	MM	IM	GAM	MM	GAM
rel deal value	-	-	-	-	-	-	-*	-	-*	-	-	-
pct acquired	-	-	-	-	-	-	-	-**	-	-**	-**	-**
same industry	+	-	+	-	-	-	+	+	+	+	+	+
mtb similarity	-	-*	-	-	-*	-	-**	-**	-**	-	-**	-
size similarity	+	-	+	-	-	-	-	-**	-	-*	-**	-*
q	-**	-***	-**	-***	-***	-***	-*	-***	-*	-**	-***	-**
roa	+***	+***	+***	+	+***	+	+**	+**	+**	+	+**	+
sales growth	-*	-**	-*	-***	-**	-***	-	-*	-	-**	-*	-**
leverage	+	+	+	+	+	+	+	+	+	+	+	+
ln mva	-**	-***	-**	-***	-***	-***	-	-**	-	-***	-**	-***
asset utilisation	+	+	+	+	+	+	+*	+**	+*	+**	+**	+**
expense ratio	-	-	-	-	-	-	-	-	-	-	-	-
div on assets	+	+	+	+*	+	+*	+	+	+	+	+	+
investment	-***	-	-***	+	-	+	-**	-**	-**	-**	-**	-**
tangible	+*	+*	+*	+	+*	+	+***	+***	+***	+***	+***	+***
intensity	-***	-***	-***	-***	-***	-***	-***	-***	-***	-***	-***	-***
herfindahl	-**	-***	-**	-**	-***	-**	-***	-***	-***	-***	-***	-***
gdp growth	-**	-*	-**	-*	-*	-*	-*	-	-*	-*	-	-*
Constant	+**	+**	+**	+**	+**	+**	+**	+***	+**	+***	+***	+***

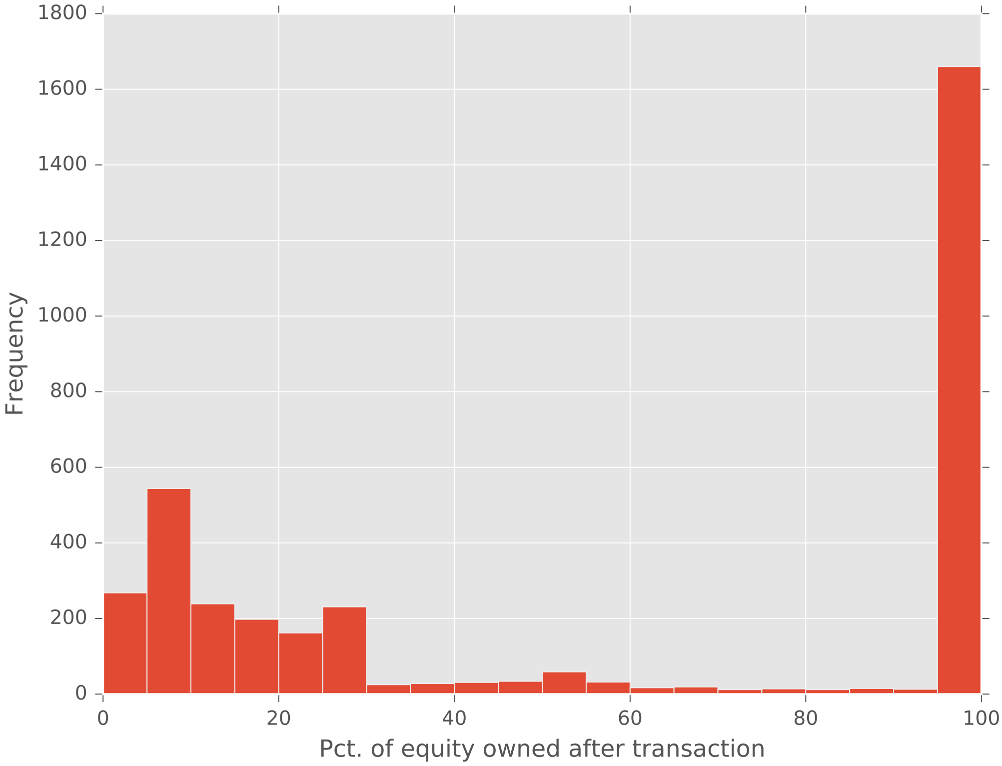
Panel B: Short term models (CAR t_0 to t_{10})

	All events						Corrected events only					
	IM	MM	IM	GAM	MM	GAM	IM	MM	IM	GAM	MM	GAM
rel deal value	+	+	+	+	+	+	-	-	-	-	-	-
pct acquired	-	-*	-	-*	-*	-*	-	-	-	-	-	-
same industry	+	+	+	+	+	+	-	-	-	-	-	-
mtb similarity	+	+	+	+	+	+	-	-	-	-	-	-
size similarity	+	-	+	+	-	+	-	-**	-	-	-**	-
q	-**	-***	-**	-***	-***	-***	-***	-***	-***	-***	-***	-***
roa	+**	+***	+**	+***	+***	+***	+***	+***	+***	+***	+***	+***
sales growth	-***	-***	-***	-***	-***	-***	-***	-***	-***	-***	-***	-***
leverage	+***	+***	+***	+***	+***	+***	+**	+**	+**	+**	+**	+**
ln mva	-***	-***	-***	-***	-***	-***	-***	-***	-***	-***	-***	-***
asset utilisation	-	-	-	-	-	-	+	-	+	+	-	+
expense ratio	+	+**	+	+**	+**	+**	+	+	+	+	+	+
div on assets	+	+	+	+	+	+	-	-	-	-	-	-
investment	-*	-	-*	-	-	-	-	-	-	-	-	-
tangible	+	+	+	+	+	+	+	+	+	+	+	+
intensity	-	-	-	-	-	-	-	-	-	-	-	-
herfindahl	+**	+*	+**	+*	+*	+*	-	-	-	-	-	-
gdp growth	-	-	-	-	-	-	+	+	+	+	+	+
Constant	+***	+**	+***	+**	+**	+**	+**	+**	+**	+**	+**	+**

Notes: This table contains a descriptive comparison of the regression model results. Panel A compares long-term CAR models (Table 2.9) and Panel B compares short-term CAR results (Table 2.10). In each panel, the left three columns refer to models using all events and the three rightmost columns refer to models using corrected events only. IM is Index Model, MM is Market Model and GAM is GARCH-Adjusted Model. Variable definitions are in Table A.1 .

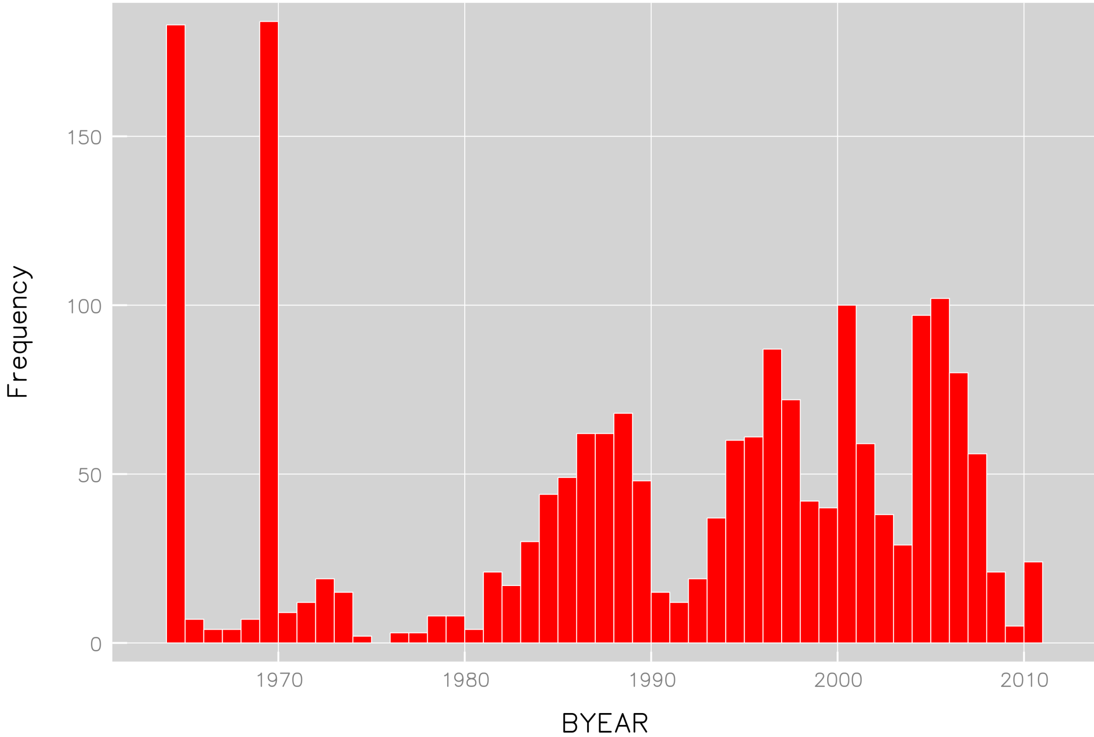
Appendix B

Supporting Evidence to Chapter 3



The graph shows frequencies of the percentage of the target's equity owned after acquisition by the bidder. Possible cut-offs for controlling acquisitions (anything over 75%) are dominated by 100% acquisitions, which is why we have opted for this strict definition of control. The effect of acquisitions at smaller cut-offs is negligible.

Figure B.1: Histogram of percentage equity owned after successful acquisition



The graph shows frequencies of the BYEAR variable for each unique company in the sample of Table 3.6, model 2. The variable is used for the calculation of duration which is an important input in our models. With two spikes at 1964 and 1969, the graph emphasises the need for the inclusion of the *start* variable in our models, that controls for the artificial winsorisation imposed by DataStream's cap at 1964 in our sample.

Figure B.2: Histogram of individual companies' BYEAR

The graph shows frequencies of the maximum duration per unique company in the sample of Table 3.6 model 2. The spike on the maximum value gives additional support for the inclusion of the *start* variable in our models. The distribution corresponds to a Weibull distribution with shape parameter < 1 (after controlling for the artificial BYEAR winsorisation imposed by DataStream).

Figure B.3: Histogram of individual companies' maximum age

Table B.1: Robustness test with alternative excess r dummy

	(1)	(2)	(3)
asset utilisation	0.002	−0.008	0.021
	(0.053)	(0.058)	(0.059)
expense ratio	0.033	−0.060	−0.248
	(0.219)	(0.239)	(0.219)
div on assets	−0.043	−0.073	−0.020
	(0.062)	(0.067)	(0.066)
investment	0.046	0.067	0.135
	(0.133)	(0.135)	(0.123)
leverage	0.052	0.021	0.077
	(0.071)	(0.080)	(0.080)
roa	−0.164**	−0.225**	−0.079
	(0.086)	(0.101)	(0.106)
sales growth	−0.150	−0.112	−0.008
	(0.209)	(0.208)	(0.187)
tangible	0.167	0.217	0.096
	(0.108)	(0.111)	(0.105)
d market	0.514***	0.573***	0.478***
	(0.138)	(0.167)	(0.169)
start	−2.650***	−2.660***	−1.954***
	(0.128)	(0.129)	(0.147)
ln mva			0.128*
			(0.073)
mtb similarity			0.478***
			(0.128)
size similarity			0.223***
			(0.055)
intensity			114.067***
			(6.370)
herfindahl			7.009***
			(1.073)
gdp growth			14.490***
			(2.661)
asset utilisation:d market		0.091	0.070
		(0.155)	(0.159)
expense ratio:d market		0.484	0.564
		(0.532)	(0.520)
div on assets:d market		0.480**	0.421**
		(0.196)	(0.198)
investment:d market		−0.246	−0.228
		(0.257)	(0.247)
leverage:d market		0.181	0.216
		(0.172)	(0.175)
roa:d market		0.223	0.056
		(0.200)	(0.209)
sales growth:d market		−0.123	−0.111
		(0.290)	(0.279)
tangible:d market		−0.288	−0.300
		(0.176)	(0.178)
d market	d excess r decile alt		
N	20 076	20 076	19 938
Number of events	586	586	586
Number of events in d market	67	67	67
R^2	0.028	0.029	0.050
Max. Possible R^2	0.404	0.404	0.406
Log Likelihood	-4913.040	-4905.396	-4688.011
Wald Test	449.970***	468.580***	1210.790***
LR Test	567.480***	582.769***	1016.077***
Score (Logrank) Test	664.873***	685.743***	1263.443***

Notes: d excess r decile alt is an alternative specification of d excess r decile of Table 3.7 and Table 3.8. In this table the dummy is created after missing observations are dropped so that its mean across the sample is 0.10. The model confirms the previous finding of higher takeover risk for the low excess r set with little relation to firm fundamental variables of that set. The exception in this case is dividends, which are significant on the interaction term. Variable definitions are in Table 3.3. The models contain interactions of investment, tangible, sales growth, mtb similarity, intensity and herfindahl with duration in order to protect the proportional hazards assumption. *p<0.1; **p<0.05; ***p<0.01 Standard errors in parentheses.

Appendix C

Supporting Evidence to Chapter 4

Table C.1: Dickerson Style Modelling

	(1)	(2)
ln mva	−0.099***	−0.148***
	(0.022)	(0.046)
tangible	4.580***	0.014
	(0.319)	(0.050)
leverage	0.182	0.152***
	(0.250)	(0.070)
roa	0.302	−0.113
	(0.303)	(0.076)
div on assets	0.294	−0.031
	(2.806)	(0.081)
investment	−0.053	−0.031
	(0.995)	(0.090)
d market	−0.050	0.307***
	(0.140)	(0.093)
start	−2.114***	−2.637***
	(0.137)	(0.126)
div on assets:d market	7.453***	0.193*
	(2.618)	(0.114)
investment:d market	1.712	0.143
	(1.174)	(0.111)
Standardised values	No	Yes
d market	d q median overall	d q median
N	20 494	20 494
Number of events	592	592
Number of events in d market	383	372
R^2	0.039	0.028
Max. Possible R^2	0.401	0.401
Log Likelihood	-4846.352	-4965.398
Wald Test	790.530***	431.080***
LR Test	821.998***	583.908***
Score (Logrank) Test	927.226***	674.020***

Notes: The table depicts Cox PH models with the indicated variables with full (100%) takeover as the event in the next period. Model 1 uses unstandardised values similar to Dickerson et al. (2002) and model 2 uses industry-year standardisation similar to Chapter 3, Chapter 4 and Loderer & Waelchli (2015). Accordingly the d market dummy in model 1 is using the bottom median for TQ for the whole sample and model 2 uses the bottom median per industry-year group. Variable definitions are in Table 4.3. Model 1 contains interaction terms of dividends and tangible with duration for the protection of Cox PH assumptions.